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10.0 ESSENTIAL FISH HABITAT

10.1 Introduction

In 1996 Congress reauthorized the Magnuson Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), which required NMFS to describe and identify essential fish habitat (EFH) for the fishery based on the guidelines established by the Secretary under section 305(b)(1)(A), minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of EFH. In doing so, Congress recognized the importance of habitat in maintaining viable and sustainable fisheries. EFH is defined as those habitats necessary to the species for spawning, breeding, feeding, or growth to maturity. The EFH guidance published on January 17, 2002 (67 FR 2343) stated that EFH must be identified and described for each life stage and for all species in the fishery management unit (FMU), as well as the physical, biological, and chemical characteristics of EFH, and, if known, how these characteristics influence the use of EFH by each species and life stage. FMPs and FMP amendments must provide written descriptions of EFH and must also provide maps of the geographic locations of EFH or the geographic boundaries within which EFH for each species and life stage is found (50 CFR 600.815(a)(1)(i)).

The Magnuson-Stevens Act states that NMFS should periodically review and revise or amend the EFH provisions as warranted based on available information (50 CFR 600.815(a)(10). The EFH guidance further states that NMFS should review all EFH information at least once every five years. EFH, including habitat areas of particular concern (HAPCs), for HMS were identified in the 1999 HMS FMP. This amendment constitutes Phase 1 of the comprehensive five-year review of EFH for all HMS. The purpose of the EFH review is to gather any new information and determine whether modifications to existing EFH descriptions and delineation's are warranted. While NMFS has presented new information relative to HMS EFH in the annual Stock Assessment and Fishery Evaluation (SAFE) reports, this is the first comprehensive review of all new information related to EFH that has been completed since 1999.

NMFS does not intend to modify any of the existing EFH descriptions or boundaries in this FMP or to minimize impacts from fishing gear. Rather, NMFS is presenting new EFH information and data collected since 1999, including gear evaluations, and requesting public comment on any additional data or information that may need to be included in the five-year review. Based on an assessment of the data collected thus far, NMFS has made a preliminary determination that modification to existing EFH for some species and/or life stages may be warranted. At this time, even though NMFS is conducting the gear evaluations, NMFS is not minimizing any impacts due to fishing gears. Any modifications to existing EFH descriptions and boundaries and potential measures to minimize fishing impacts would be addressed in a subsequent FMP action. In order to consolidate EFH descriptions and maps previously provided in separate documents, all of the EFH descriptions and maps from the 1999 FMP, Amendment 1 to the FMP, and Amendment 1 to the Billfish FMP are provided in this FMP. Maps in this FMP include data acquired through the review process and will provide an opportunity for public comment on the need for any additional information to be considered. These maps can be found in Appendix B.

To further the conservation and enhancement of EFH, the EFH guidelines encourage FMPs to identify HAPCs. HAPCs are areas within EFH that meet one or more of the following criteria: they are ecologically important, particularly vulnerable to degradation, undergoing stress from development, or they are a rare habitat type. HAPCs can be used to focus conservation efforts on specific habitat types that are particularly important to the managed species. Currently, only three HAPCs for sandbar sharks have been identified, including: three separate areas off North Carolina; Chesapeake Bay, MD; and Great Bay, NJ (NMFS, 1999). Although no new HAPCs have been identified since the 1999 FMP, and none are proposed in the current Amendment, NMFS may consider alternatives for HAPCs in a subsequent FMP action, based upon information provided by experts in the field or from other information gathered during this review. Once additional information is compiled and analyzed for the five-year EFH review, additional HAPC alternatives may be proposed.

Additionally, FMPs are required to identify fishing and non-fishing activities and to minimize any adverse effects on EFH. Each FMP must include an evaluation of the potential adverse impacts of fishing on EFH designated under the FMP, including effects of each fishing activity regulated under the FMP; also the effects of other Federal FMPs and non-Federally managed fishing activities (*i.e.*, state fisheries) on HMS EFH. FMPs must describe each fishing activity and review and discuss all available relevant information such as the intensity, extent, and frequency of any adverse effects on EFH; the type of habitat within EFH that may be adversely affected; and the habitat functions that may be disturbed (§ 600.815(a)(2)). If adverse effects of fishing activities are identified, the Magnuson-Stevens Act requires that these effects on EFH are minimized to the extent practicable (MSA § 303(a)(7)).

NMFS completed the original analysis of fishing and non-fishing impacts in the 1999 FMP, and is now presenting information gathered to complete the five-year review, including all fishing and non-fishing impacts. Considerable new information is available regarding gear impacts that have been incorporated into this review. For example, new information presented in the Gulf of Mexico and Caribbean Fishery Management Council EFH FEIS' (2004) suggest that bottom longline gear may have an adverse affect on coral reef habitat which serves as EFH for certain reef fishes, and both Councils have taken action to minimize fishing impacts on those areas. Bottom longline gear in HMS fisheries is primarily used in sandy and/or muddy habitats where it is expected to have minimal to low impacts. An assessment of whether HMS bottom longline gear is fished in coral reef areas, and if so, the intensity, extent, and frequency of such impacts, including any measures to minimize potential impacts will be considered in a subsequent rulemaking. At that time, NMFS may consider similar alternatives to prohibit HMS gears in those areas identified by the Councils, or other areas identified by NMFS. Other gear types that contact the bottom, such as tuna traps or anchored gillnets, are either so few in number, as in the case of the tuna traps, or are also used in sand or mud habitats, as is the case of the anchored gillnets, that impacts from these HMS gear types are expected to be minimal, and will be addressed in a subsequent rulemaking.

10.2 EFH Five-Year Review Process

The original identification and description of EFH for HMS was completed for tunas, swordfish, and sharks in the 1999 FMP, and for billfish in the 1999 Amendment 1 to the Billfish FMP. Amendment 1 to the 1999 FMP included a review and update of EFH for five shark species. EFH for these species was updated based on either a change in management status (*e.g.* from overfished to not overfished or vice versa) or based on new information that had become available. Species for which management status had changed included the blacktip shark (*Carcharhinus limbatus*) (no longer overfished), sandbar shark (*C. plumbeus*) (overfishing is occurring), and finetooth shark (*C. isodon*) (overfishing is occurring). Species for which new information had become available included the dusky shark (*C. obscurus*) and nurse shark(*Ginglymostoma cirratum*). As described above, these updated descriptions and maps are included in this Amendment.

As part of the five-year review process, a search of all new literature and information on HMS EFH was undertaken to assess habitat use and ecological roles of HMS EFH in the FMU. Published and unpublished scientific reports, fishery independent and fishery dependent datasets, and expert and anecdotal information detailing the habitats used by the managed species were evaluated and synthesized for inclusion in the five-year review process in this FMP Amendment (See Section 10.3). Ongoing research on the biology, ecology, and early life history of Atlantic HMS, and research and publications relating to HMS EFH, are described in greater detail below.

10.2.1 Descriptions of Datasets Used in the Review

A number of different data sets from state, Federal, and non-governmental organizations were compiled during the review process. For the most part, these are updated versions of the same data sources that were used for the original 1999 EFH identifications. One new data set, from the Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) program, was initiated in 1998 by the Northeast Fisheries Science Centers (NEFSC) Apex Predator Program (APP). Although several of the data sets described below appear to be focused on a particular species, there may be an overlap in the species that are documented, particularly in the tagging programs. For example, the Cooperative Shark Tagging Program (CSTP), described below, includes data on 114 adult white marlin tagged between 1964 and 2002, and 318 juvenile white marlin tagged between 1967 and 2003, even though the primary focus is on Atlantic sharks.

The CSTP, managed by the NEFSC APP, provides one of the most comprehensive, long-term data sets available on Atlantic sharks and, to a lesser degree, swordfish, tunas, and billfish. The CSTP data set has a continuous time series of observations dating back to 1962. Between 1962 and 2004, more than 171,000 sharks of 52 species have been tagged and more than 10,000 sharks of 33 species have been recaptured. Information is collected by distributing tags to scientists and commercial and recreational fishermen who record information on the species, capture or tagging location, date, gear, and size of the tagged fish prior to its release.

The NEFSC APP has also been conducting surveys since 1986 which represented the first systematic survey of sharks covering most of the U.S. Atlantic coast from Southern New England to mid-Florida in depths of 5 to 200 m. Pre-determined stations were positioned roughly 30 nautical miles (nmi) apart, with additional (tagging only) stations in regions of high shark abundance. The cruise was designed to obtain baseline information on the abundance and distribution of large pelagic fishes, primarily sharks, using standard pelagic longline gear. By 1989, the objectives of the survey were shifted from pelagic fish to large coastal sharks and this survey covered the waters from Tampa, FL, to southern New England. The gear was weighted and the bottom longline survey was initiated. Survey procedures and gear were standardized between the NEFSC and Southeast Fisheries Science Center SEFSC in 1995 to make the surveys comparable and to mimic the gear used in the commercial large coastal shark fishery. Changes to the NEFSC survey were: 1) gear changed from New England pelagic (rope mainline, rope and wire gangions) to Florida bottom (monofilament mainline and gangions), 2) soak time increased from 1 to 3 hrs, 3) bait changed from mackerel to spiny dogfish, 4) stations limited to depths between 5 and 40 fms, and 5) longline fished entirely on the bottom, eliminating the pelagic sets of the previous surveys, 6) 300 hooks fished rather than 100.

The Cooperative Tagging Center (CTC) operated by the SEFSC was established in 1992 in response to expansion of tag release and recapture activities, data requests from other tagging agencies, and domestic and international tagging research needs. The CTC runs the Cooperative Tagging System (CTS), and other projects aimed at tagging research and cooperative work with endangered species emphasizing highly migratory species such as tunas and billfishes. The CTC collects catch, effort, tagging, and bio-profile data on tunas and billfish to monitor trends in abundance.

The Commercial Shark Fishery Observer Program (CSFOP), also referred to as the Shark Observer Program (SOP), administered by the Florida Museum of Natural History, University of Florida, has been collecting information on the directed shark bottom longline fishery since 1994. A voluntary program for many years, it became mandatory in 2002. Trained observers collect fishery-dependent information on the location of each longline set, species composition, number of each species caught, disposition of the catch, and information on individual sharks such as length and sex. The coverage for this data set extends from the Atlantic east coast to the Gulf of Mexico. Data from this program are essential to monitoring the fishery and providing distributional information for many different shark species.

The Pelagic Observer Program (POP), administered by SEFSC in Miami, has been monitoring the commercial pelagic longline fishery since 1992. The program places trained observers aboard commercial fishing vessels, monitoring the U.S. pelagic longline fleet in the Atlantic and Gulf of Mexico. Observers collect information on location, number of fish caught per set, species identification, sex, length, and weight for swordfish, sharks, tunas, and billfish. The POP targets approximately 8 percent of the vessels based on the fishing effort of the fleet, and supplies data on all species included in the 1999 FMP.

The COASTSPAN program, also administered by the NEFSC APP, has been collecting information on shark nursery areas for several Atlantic east coast states since 1998. The purpose of these surveys is to assess the geographical and seasonal extent of shark nursery habitat, determine which shark species use these areas and gauge the relative importance of these coastal habitats. NOAA scientists and state and university researchers monitoring shark populations in Delaware, North Carolina, South Carolina, Georgia, and Florida collect the information. In 2002, a synthesis document of research including several other states bordering the Atlantic east coast and Gulf of Mexico was completed, resulting in additional information on shark EFH. The information included in this data set was derived through a variety of collecting methods including longline, gillnet and trawl surveys, and standardized to include information on location, species, length, and data source.

The Southeast Fishery Longline Shark Survey, administered by the SEFSC, Pascagoula Laboratory, has been conducting biological surveys to assess the relative abundance and distribution of coastal sharks since 1995. Biological data is collected from all captures and associated environmental data is recorded from each longline location. Most of the sharks captured are tagged and released. The longline surveys provide a useful fisheries independent database for sharks.

The Mote Center for Shark Research (CSR), operated out of the Mote Marine Laboratory (MML), includes data on sharks and any tuna and billfish bycatch. MML is an independent, nonprofit marine research institution with a nearly 50-year history of shark research, including: collecting angler tag data to provide basic biological information on shark migrations, age and growth studies, natural mortality studies, and investigations on behavior and habitats.

The Southern Atlantic SEAMAP Shallow Water Trawl Survey, administered by the South Carolina Department of Natural Resources is a state sponsored public tagging program. Over the past twenty-seven years, close to12,000 anglers have participated in the program. Over 100,000 fish have been tagged with an overall recovery rate of around 13 percent. Species tagged include sharks, tunas, and billfish. For example, a blue marlin tagged through SEAMAP became the first documented Atlantic blue marlin to cross the equator. This marlin was tagged off Georgetown, South Carolina and was recaptured several months later 750 miles off the coast of Brazil. It had traveled approximately 4,300 nautical miles from its original tagging location.

The Virginia Institute of Marine Science (VIMS) longline survey began in 1973 and is still continued today. This project allows VIMS scientists to assess the abundance of local shark stocks and to monitor changes in this abundance over time. The survey is a depth-stratified field survey of the Chesapeake Bay and Virginia coastal waters.

The Billfish Foundation (TBF) is a non-profit organization that has been collecting data on billfish tagging for a number of years, and providing the data to the NMFS SEFSC. The Billfish Foundation developed the widely used hydroscopic nylon tag head, which has been employed in offshore and inshore fisheries tagging efforts. In addition, TBF has contributed to the development and use of satellite tagging technology for marlin.

In addition to these data sets, data were obtained from individual researchers involved in shark, tuna, swordfish, and billfish research. For example, in 2002 a synthesis document of shark nursery research conducted along the U.S. Atlantic and Gulf of Mexico coasts was initiated, resulting in additional information on shark EFH. The data collected by the various researchers were synthesized into a single standardized data set to provide a comprehensive view of shark nursery and pupping areas in state waters. The information included in this data set was derived through a variety of collecting methods including longline, gillnet and trawl surveys, and standardized to include information on location, species, length, and data source.

The Pelagic Longline Logbook (PLL), a comprehensive fisheries dependent logbook reporting system, was also compiled during the review, but could not be included in the maps due to the lack of size information. The PLL data include, among other things, targeted species caught, bycatch, effort, and gear. However, since EFH descriptions are based on different lifestages of HMS, information on sizes is required for EFH mapping and analysis. Thus, NMFS was only able to use the PLL data to confirm the presence of HMS in areas that appeared to be outside of the normal distribution range of points from other data sets.

10.2.2 Methods Used to Map and Analyze EFH Data

The overall approach used to analyze data and identify EFH is described in the EFH regulations (§ 600.815(a)(1)) and was followed during the initial identification of HMS EFH in 1999, as well as during this five-year review. The regulations recommend using an approach of categorizing data according to different levels. The regulations require that, at a minimum, distribution data (level 1 information) be used to identify EFH. This level 1 information is based on presence/absence data of the species or life stages in specific habitats used. Where possible, data sets and information on habitat-related densities of species (level 2), growth, reproduction and survival within habitats (level 3), and production rates by habitat (level 4), should be used to identify EFH. Distribution data (level 1) are the most common data available for HMS. As described in further detail below, the interpretation and application of these data are subject to certain limitations.

As part of the review process NMFS scientists who have expertise working with HMS were consulted to determine whether the data included in the updated maps for this amendment were appropriate, whether appropriate size ranges for species' individual life stages applied to the mapped data points, and whether modifications to existing EFH areas may need to be considered in the future. For mapping purposes, there were no changes to the size ranges for the three life stages of tunas, swordfish, or billfish from the 1999 FMP. However, the naming conventions for the life stages were modified slightly to provide clarity and help distinguish between them. Size ranges for each of the species' life stages are indicated on the bottom of each of the maps. Due to a lack of published literature on length-at-age data for several HMS, NMFS changed the 1999 categories for size classes of tunas, swordfish, and billfishes from juvenile/subadults to juveniles only. NMFS is aware of the inherent difficulties in accurately determining the size, sex, and in certain cases, species for classification purposes (described in more detail in section 10.3).

After reviewing published scientific reports and consulting with experts in the field, NMFS believes that several of the size ranges for various life stages of sharks may need to be changed from those described in the 1999 FMP. Identifications and descriptions of shark life stages by size are provided in Appendix B. The data points on the maps provided in this Amendment represent these new size ranges. The data points reflect a "neonate" life stage (where available) and do not contain an "early juvenile" life stage, as was the case in the 1999 FMP. The 1999 definition was modified to include primarily neonates and young-of-the-year sharks in the neonate category in order to better define and identify the life stage that occupies nursery habitat. The change in classification of "late juveniles/subadults," to "juveniles" was done to ensure that all immature sharks from young juveniles to older or late juveniles were included in the juvenile category. Finally, the "adult" size class still consists of mature sharks based on the size at first maturity for females of the species. Similar modifications to other HMS species' size ranges may be undertaken in the future.

After careful screening to ensure standardization and quality of the data, all of the data points for each species were compiled in a Geographic Information Systems (GIS) program for mapping. By combining all of the data sets, the number of observations for an individual life stage for a single species ranged from several hundred to over 18,000. Each observation included at a minimum the species, size, life stage, latitude and longitude coordinates, date of collection, sex, and data source.

Identifying areas with the highest concentration of observations was determined by superimposing individual observations on a regional grid covering coastal waters in the U.S. Exclusive Economic Zone (EEZ). The grid was constructed of ten-minute squares that are all equal to 0.0279 square degrees or 100 square degree minutes[1], or approximately 100 nm^2. The grid and individual data points were spatially joined and each square was given a summary of the numeric attributes and a count field of the points that fell inside it. Depending upon the species, the number of observations per 100 nm^2 ranged from zero to several thousand. The squares containing observations were color-coded depending upon the number of observations per square, and scaled to reflect the frequency of occurrence.

A grid was used rather than individual data points so that reviewers could determine the relative concentration of fish in a given area, something that is difficult to determine with overlapping data points. However, the grid and associated scale are not meant to represent abundance or density estimates (level 2 data). In addition, the grid will be helpful in future efforts to revise existing boundaries by providing a scale that can be used as a guide for the inclusion or exclusion of given areas. For example, in Amendment 1 to the FMP, criteria (presented here for reference only) for including or excluding a given number of observations per square were established for each species based on the status of the stock, and used as a guide to identify appropriate EFH areas. For a rebuilt species like blacktip shark, a criteria of greater than 10 observations per 100 nm^2 was used to help identify and map areas as EFH. For an overfished species such as finetooth shark, a more precautionary criteria of > 1 observation per 100 nm^2 was used to help identify and map EFH areas. Thus, the grid might be used in a future rulemaking to analyze potential alternatives based on including or excluding a specific number of observations per 100 nmi^2 area.

[1]A minute of latitude equals a nautical mile, but the distance represented by a minute of longitude varies according to distance from the equator. Thus, ten minute "squares" are larger in size near the equator and get progressively smaller in size as you approach the poles.

Due to natural variability in abundance for different species and lifestages, which is reflected by the variation in the number of observations per 100 nm^2, the relative concentrations were tailored to each species. NMFS adopted this approach because it made the data easier to view and analyze, but there may also be a benefit to a uniform scale for certain species and lifestages.

10.3 Summary of Review and Findings

As part of the review process, NMFS provided draft maps of the 1999 EFH boundaries overlayed both new and existing data for each HMS to technical reviewers for their feedback and comment. Several reviewers raised concerns regarding identification of EFH for a number of reasons described in further detail below. The comments ranged from questions regarding size classifications for various species' life stages to potential errors in species identification. NMFS is providing a summary of these comments and observations so that the public and others reviewing the current distributions and maps will have a better understanding of the issues involved in interpreting the data, and ultimately modifying EFH.

One of the overarching comments was the challenge of identifying EFH for tunas, swordfish, billfish, and sharks, and the limitations of relying too heavily on distribution data alone. By nature, these species are highly migratory and occupy a wide range of habitats including estuarine, coastal, and offshore pelagic environments. HMS are typically associated with oceanographic features such as fronts, current boundaries, temperature discontinuities, or water masses with particular physical characteristics, which may be ephemeral, difficult to map, and difficult to correlate with specific periods in which they are occupied by HMS. Other features such as shelf edges and sea mounts are more easily identified and may be sites of higher abundance for some HMS on a seasonal basis. In the past, areas with readily identifiable geographic or bathymetric features that coincided with, or overlapped with areas of HMS aggregations, were used to delineate the boundary, or a portion of the EFH boundary. Where expert opinion was available and data points were scarce, areas were identified as EFH based on the best interpretation of life history accounts.

Distribution data alone may not provide sufficient information on whether the habitat should be considered essential even if correlations can be drawn between the presence of HMS in a given area and a particular habitat. For many HMS, additional information from surveys, or observations of feeding or spawning activity may be used to further confirm the importance of the habitat. Information about the life history of a particular species, such as the timing of the reproductive cycle, may also be used to correlate the presence of HMS in an area. However, as described in greater detail below, these types of correlations are difficult to confirm, are not well documented in the scientific literature, and should be viewed with caution. Due to difficulties in identifying EFH, a precautionary approach of selecting large areas has been used in the past.

EFH information for most of the data sets described above is based on distribution information (level 1) derived from systematic presence/absence sampling and relative abundance (CPUE) data. Level 2 density information (*i.e.*, number of sharks/m^3) is generally not available due to the types of gear used to collect HMS. For example, data from the McCandless *et al.* (2002) report on shark nursery areas in coastal waters were gathered using a wide variety of sampling techniques including gillnet, longline, and trawl surveys. Of the 15 separate research studies conducted from Massachusetts to Texas that contributed to the McCandless *et al.* (2002) report, only one provided trawl data that might have been used to generate habitat related densities. Additional equipment would have been needed to collect information on water volume sampled in order to estimate densities. The other sampling techniques (gillnet and longline) provide presence/absence or relative abundance through CPUE data (*e.g.* number of sharks/gillnet hour, or number of sharks/100 hooks), but not density data. Additionally, due to the differences in fishing effort, a cross comparison of CPUE among the different studies was not possible. Due to the types of gear used to sample other HMS (longline, rod and reel, handline, harpoon), similar difficulties are encountered for nearly all HMS. However, the information may nonetheless prove to be useful in providing a broad overview of the regional distributions, habitat requirements, and nursery areas for a wide variety of species.

Despite the lack of density information, other valuable information may be derived from studies such as these, including data on growth rates from recaptured tags and habitat utilization information through sampling, telemetry, and tagging efforts. By determining the life stage of a species at capture, through size measurements, additional information may be derived about habitat utilization. Information on where and when HMS are located in a given area, how long they may have been in the area, when migrations occur, and whether they return to the same area in subsequent years may be determined. In combination, all of these data help to determine habitat value and provide a more complete overview of habitat utilization than simple distribution data might suggest.

To the extent possible, these and other types of information from studies of life history dynamics of HMS, reports, and expert opinion are utilized to identify EFH. The sources that were used to identify EFH areas are referenced in the text. When environmental information was available, it was included in the EFH descriptions. The information included temperature, dissolved oxygen, salinity ranges, depths, seasons, and geographic locations. The textual accounts for each species serve as the legal description of EFH, and where environmental characterizations are known they have been included. Maps are provided as supplemental material to facilitate the description and identification of EFH.

Additionally, NMFS conducted a review of new publications related to HMS EFH and has provided a summary of ongoing EFH research efforts. For each of the HMS groups, the major issues involved with identifying and describing EFH are discussed in greater detail below. One of the major considerations for any future adjustments to existing EFH boundaries will be whether the existing areas can be refined. Currently, HMS EFH encompasses the entire U.S. EEZ from the U.S. Atlantic and Gulf coast to the border of Mexico. One of the objectives of the proposed modifications in the future would be to reduce the scope of HMS EFH while still providing the maximum amount of habitat protection. This may require additional research on HMS habitat use which could be related to landings and logbook data to establish definitive relationships between fish presence and what is deemed essential fish habitat.

10.3.1 Tunas

In recent years, archival tags and popup satellite tags (PSATs) have been used to successfully monitor ocean-wide movements of giant bluefin tuna as well as other HMS (Block *et al*., 2001, 2005, Lutcavage *et al*., 1999). This technology has greatly expanded the understanding of migratory patterns, reproductive behavior, and habitat use for bluefin tuna as well as other HMS such as blue and white marlin (NMFS, 2004). However, despite these advances, there are considerable gaps in the understanding of habitat requirements as they relate to identifying EFH for tunas. Accurate identification of certain species of tunas can be difficult unless one has sufficient knowledge to check for appropriate distinguishing characteristics. This is particularly true for planktonic larval stages of all tuna species and adult stages of bigeye and blackfin tuna. For example, bigeye tuna may easily be mistaken for blackfin or juvenile yellowfin tuna, and can only be positively distinguished from one another by examining the liver and gill rakers. Reviewers raised concerns regarding presence of a high number of bigeye tuna in the Gulf of Mexico, which are much more rare than blackfin tuna, and which may have been misidentified. The distribution maps for bigeye tuna indicate a significant number of observations in the Gulf of Mexico that may need to be reviewed and reanalyzed for accuracy prior to any modifications being made to existing boundaries (J. Lamkin, pers. comm.).

The Tag A Giant (TAG) program is a collaborative effort among scientists from Stanford University, the Monterey Bay Aquarium, and NMFS which continues to place electronic tags internally and externally on Atlantic bluefin tuna in the North Atlantic to continuously record data. Tag A Giant deployed 201 archival and 37 pop-up satellite archival tags (PSATs) over the past two years, during which time 21 archival tags were recovered, more than a third of which were recaptured east of the 45 degree management line. The program has collected over 13,000 geopositions obtained from 330 bluefin tuna. It is now possible to examine data in relation to year class, season, and spawning grounds visited. Bluefin tuna tagged in the western Atlantic have migrated to both the Mediterranean and Gulf of Mexico spawning grounds. Most migration to spawning grounds in the Gulf of Mexico occurred in the spring months where spawning fish appear to prefer mesoscale cyclonic eddies in the western Gulf. Results indicate that spawning occurs in the Gulf of Mexico primarily during the months of April to June (Block *et al*., 2005).

The results attained from the TAG program detail the movements and behaviors of Atlantic bluefin tuna. These data answer questions about habitat preferences, spawning and feeding grounds, spawning site fidelity, the level of mixing between eastern and western stocks, and how movements are influenced by age class and season. Linking biological data with environmental data can assist in understanding relationships between the bluefin's physical environment and its behavior, movements, abundance and distribution, leading to predictive models enabling researchers to estimate the abundance and distribution of bluefin based on oceanographic features, season, and year class. This information is being collected primarily for ICCATs consideration in updating management strategies and quotas that reflect the bluefin tunas life history in the Atlantic Ocean.

Data collected to date consistently show that spawning occurs primarily after the bluefin reach 10 years of age. Bluefin tuna that are 8.5 years and younger tend to remain near New England in the summer and fall whereas older fish move offshore, many traveling to the east of the 45 degree management zone to the Mid-Atlantic Bight and Flemish Cap. Seasonal patterns are also apparent. Bluefin tuna remained in the coastal and offshore waters of North Carolina and the South Atlantic Bight throughout the winter months, predominately over the shallow continental shelf. In the spring, most fish move north depending on age class, where they remain for the summer before returning to the south in the fall. The movements among regions appear to be dependent on temperature.

In 2002 and 2003, the TAG program expanded tagging efforts to New England, off the coast of Nantucket to spread efforts over a broader area. In 2003, efforts were expanded to the eastern Atlantic off the coast of Ireland where the program has obtained the first data on a new group of fish that have not yet been studied with this technology. Deploying tags off Ireland will also increase the likelihood of documenting the behaviors of fish spawning in the Mediterranean for comparison to those spawning in the Gulf of Mexico. The improved understanding of bluefin movements and behaviors has important applications for management and can serve as the basis for necessary changes in current management strategies.

Beginning in 1997, studies led by the New England Aquarium have implanted pop-up and pop-up archival satellite tags (PSATs) on western Atlantic bluefin tuna. Recent studies involved the implantation of PSATs into 68 Atlantic bluefin tuna in the southern Gulf of Maine and off the coast of North Carolina between July 2002 and January 2003 (Wilson *et al*., In Press). Most of the fish tagged in the southern Gulf of Maine in late summer/early fall remained in that area until late October, consistent with previous studies. Of the 33, 14 remained in northern shelf waters (between Maryland and Nova Scotia), 14 moved south to waters off the coasts of Virginia and North Carolina, and five were in offshore waters of the northwestern Atlantic Ocean. In the spring, six of the 11 fish either stayed in northern waters or moved to that area from Virginia and North Carolina waters, and the other five fish moved offshore into the Mid-Atlantic Ocean. Similar seasonal movement patterns have been shown by individuals tagged in coastal waters off North Carolina. During the winter months, these fish remained either on the Carolina shelf or in offshore waters of the northwestern Atlantic Ocean and moved offshore along the path of the Gulf Stream in spring. By summer, many were in northern shelf waters.

Swimming depth was significantly correlated with location, season, size class, time of day, and moon phase. The greatest depth recorded was 672 m (2,218 ft), and fish experienced temperatures ranging from 3.4° to 28.7°C (38° to 83.7° F). The data show that Atlantic bluefin tuna spend the majority of their time in the top 20 m (66 ft) of the water column, descending occasionally to depths in excess of 500 m (1,650 ft). The vertical behavior of bluefin tuna differed among locations, with shallower swimming depths occurring when the fish were in inshore waters.

A recent study of the diet and trophic position of bluefin tuna in coastal Massachusetts and the Gulf of Maine used stable isotope analyses to investigate feeding habits of bluefin tuna. The results suggest that bluefin tuna feed on a variety of schooling fish, including silver hake, Atlantic mackerel, and Atlantic herring (Estrada *et al*., 2005). Juvenile bluefin tuna appear to have isotopic nitrogen signatures similar to those of suspension feeders, suggesting that nektonic crustaceans or zooplankton may contribute significantly to the diet of juvenile bluefin tuna (Estrada *et al*., 2005).

Combined, all of the studies and data are providing a higher resolution of potential spawning, feeding, and other important habitat areas for bluefin tuna. Given that there is a considerable and growing body of science on bluefin tuna, it may be one of the species for which NMFS may consider modifying the boundaries in the future. For example, although bluefin tuna spawning habitat has been described as encompassing nearly all of the Gulf of Mexico by Block *et al.* (2005), adult bluefin tuna EFH is limited to a smaller portion of the western Gulf of Mexico, and the adult EFH areas may not necessarily correspond to areas considered most likely as bluefin tuna spawning habitat (Block *et. al*., 2005). NMFS may need to reconsider these boundaries to account for new information being developed through PSAT technology and other means. Similarly, some of the highest individual counts of adult bluefin tuna (per 100 nm^2) have been observed off of North Carolina, yet these areas are not currently included as adult bluefin tuna EFH. Furthermore, the SEFSC is currently conducting a comprehensive review of larval distributions from 1984 to the present from ichthyoplankton collections in the northern Gulf of Mexico. Once larval movement due to local currents is accounted for these data may prove useful in the review of potential modification of EFH boundaries for other tunas as well.

In addition, the distribution and abundance of other tuna species (*i.e.*, albacore, bigeye, skipjack, and yellowfin tunas) have been attained through fishery data combined with other information, such as remote sensing data. Many of these species have similar bioecological responses (*i.e.*, many species are specialized in high energy foraging strategies of sustained fast swimming, searching over large areas (Sharp and Dizon, 1978; Au 1986)) and therefore, have similar physiological responses to oceanographic conditions (Ramos *et al.*, 1996). Skipjack and albacore are highly migratory tunas with active thermic exchanges with the environment (Sharp and Dizon, 1978). Consequently, their distribution is influenced by changes in marine features at different spatial and temporal scales (Ramos *et al.*, 1996). For instance, both species are visual predators and are unable to efficiently capture small pelagic prey in colder turbid upwelled waters (Ramos *et al.*, 1996). Therefore, over small spatial and temporal scales, the most suitable areas based on the physiology and feeding strategies for these two species are the boundary between warm and cold water where food and other abiotic features are physiologically optimal (Ramos *et al.*, 1996). Over longer temporal and spatial scales, such as migration pathways, sea surface temperatures generated by the Intertropical Zone of Convergence play an important role (Ramos *et al.*, 1996). In addition, concentration of food and water quality (*i.e.*, higher temperature, high concentration of oxygen and low level of turbidity) lead to the concentration of skipjack and albacore in their respective fishing grounds (the northeast Atlantic for albacore and Senegal waters 10° North to the Canarian area 28° North for skipjack; Ramos *et al.*, 1996).

Yellowfin tuna is a cosmopolitan species mainly distributed in the tropical and subtropical oceanic water of the three oceans. In the Atlantic Ocean, tagging and catch-at-size data analyses have shown that yellowfin tuna move at different scales in the whole tropical Atlantic Ocean (Maury *et al.*, 2001). Environmental conditions are probably the main causes driving migration phenomena and massive population movements (Mendelssohn and Roy, 1986; Lehodey *et al.*, 1997). Recent work by Maury *et al.* (2001) showed that on a large spatiotemporal scale (the whole ocean), low salinity was a good predictor of yellowfin habitat. Juveniles were mainly distributed in low-salinity waters (< 35 parts per thousand) whereas adults extend their range to water of 36 parts per thousand. This can be due to two reasons; for young tuna (<3 yrs old), salinity could be a marker of favorable feeding areas, such as low salinity levels in the Gulf of Guinea where freshwater runoff contains high levels of nutrients. Secondly, the metabolic cost of osmotic regulation could prevent young yellowfin tuna from reaching high salinity levels (Maury *et al.*, 2001). After breeding in the Gulf of Guinea, adults, however, disperse in an east-west fashion related to salinity and warmwater seasonal oscillations (Maury *et al.*, 2001). On a mesoscale (1000 km), north-south seasonal movements are clearly related to warmwater seasonal oscillations. Such seasonal migrations should be due to surface water temperatures where adults preferentially stay in zones of water temperature between 26 to 29° C and where deeper waters are warmer than 15° C. Juveniles stay in surface waters where the sea surface temperature is 27° C or higher (Maury *et al.*, 2001). Finally, at the local level (100 km), yellowfin tuna seem to be influenced by both local hydrological and biological features, such as tuna prey distribution and the spatial stability of water masses. For instance, the presence of floating objects, and the existence of small-scale hydrological events like local fronts or convergences can all be responsible for yellowfin concentrations (Bakun 1996).

Lastly, bigeye tuna are large epi-and mesopelagic fish that are found in surface waters ranging in temperatures from 13 to 29°C (Collette and Nauen, 1983). However major concentrations coincide with the temperature range of the permanent thermocline, between 17 and 22°C. Therefore, temperature and thermocline depth appear to be important environmental factors governing the vertical and horizontal distribution of bigeye tuna (Alvarado Bremer *et al.*, 1998). Such oceanographic features can have important implications for fisheries management; for instance, water temperature can prevent movement of fish between ocean basins, influencing stock structure (Alvarado Bremer *et al.*, 1998). On the basis of fisheries data, geographic distribution, tagging results, and the location of spawning and nursery areas, a single population is assumed to inhabit the Atlantic Ocean (ICCAT, 1997). For management purposes, both the Indian Ocean and Pacific populations are considered to be single units. Recent molecular work has indicated that the Atlantic and Indo-Pacific populations are two regions and genetically distinct (Alvarado Bremer *et al.*, 1998), confirming a single spawning stock of bigeye in the Atlantic and a single spawning stock in the Indo-Pacific. In the Atlantic Ocean, juvenile bigeye tuna have been observed only in the Gulf of Guinea (ICCAT, 1997). Tagging studies indicate trans-Atlantic movements of bigeye from the Gulf of Guinea to the central Atlantic north of Brazil, and northerly migration from the Gulf of Guinea to the eastern Atlantic (ICCAT, 1997).

As with most other HMS, salinity and temperature appear to be primary factors influencing the distribution of tunas and may ultimately determine EFH. The challenge remains in identifying specific EFH areas based solely on environmental parameters; in most cases, distribution data may still provide the best indication of habitat preference of these different species. For additional EFH information on these tuna species, see Appendix B.

10.3.2 Swordfish

Based on a review of the swordfish maps and current distribution points, reviewers commented that additional research may be needed to validate the current size ranges for juvenile and adult swordfish. In addition, further analysis may be needed to determine whether certain areas have been used consistently over time. Analyzing spawning areas that are consistently used over a number of years may provide a better understanding of swordfish EFH. Several discrepancies in distribution points and EFH areas delineated in 1999 were noted, including a high concentration of observed occurrences of juvenile swordfish in an area north of Long Island Sound that was not defined as EFH in 1999. NMFS may consider modifying swordfish EFH boundaries in the future, particularly in the Long Island Sound area, and conversely, areas currently delineated as EFH that have few if any observed occurrences in the data sets being analyzed.

Pinpointing definitive EFH for spawning swordfish is difficult because research indicates that presence of larvae may not always be a sign that spawning occurred in the vicinity of the collection. Adult swordfish, and HMS in general, may move significant distances during spawning, and eggs and larvae may be transported substantial distances by currents as well. Govoni *et. al*. (2000) determined that since a swordfish egg's incubation period is 3 days at 24°C, with an additional three or four days for posthatch growth, along with an average velocity of the Gulf Stream of 1.5 m/s (Olson *et al*., 1994), larvae of four to five mm SL in the Atlantic could have been transported from as far away as 900 km. A similar trajectory was projected for small larvae of bluefin tuna (McGowan and Richards, 1989).

10.3.3 Billfish

Similar to other HMS, billfish EFH is not easily identified due to a lack of association with readily identifiable features such as benthic habitat or other underwater structures. Billfish tend to aggregate in areas with dynamic features such as temperature gradients, ocean fronts or currents resulting from interactions between a number of factors. Many of these water column features are dynamic, making detailed delineation of billfish spawning, nursery, and feeding habitats difficult. Adding to the difficulty of designating billfish EFH is that most of the literature on billfish larvae and juveniles mention them as incidental catches in studies that were directed at other species or that were concerned with characterizing ichthyofaunal or plankton communities as a whole (NMFS, 2004).

Comments received during the Draft FMP indicate that *Sargassum* may be an important component of billfish habitat, particularly during early life stages, and that NMFS should investigate this further. If NMFS determines that EFH for some or all HMS needs to be modified, then that would be addressed in a subsequent rulemaking, at which point *Sargassum* could also be considered as potential EFH. With regard to harvest, the final South Atlantic Fishery Management Council FMP for Pelagic *Sargassum* Habitat in the South Atlantic Region was approved in 2003 and implemented strict restrictions on commercial harvest of *Sargassum*. The approved plan includes strong limitations on future commercial harvest. Restrictions include prohibition of harvest south of the NC/SC state boundary, a total allowable catch (TAC) of 5,000 pounds wet weight per year, limiting harvest to November through June to protect turtles, requiring observers onboard any vessel harvesting *Sargassum*, prohibiting harvest within 100 miles of shore, and gear specifications.

One of the key issues associated with delineating billfish EFH is the difficulty of accurately identifying billfish larvae. However, new molecular techniques are being developed that show promise (Luthy *et al.*, 2005). Without accurate identification of larvae, it is difficult to draw conclusions on spawning areas, habitat associations, and requirements. Billfish larvae may be swept miles from actual spawning grounds before they are sampled. Thus, even though peak spawning periods for blue and white marlin are known to occur from May to June, there are significant issues related to positive identification of larvae that must be overcome to verify spawning locations. Research off Punta Cana, Dominican Republic, is one of the few instances on record where spawning by blue and white marlin was confirmed through simultaneous collections of both larvae and tracking of spawning adults using pop-up satellite tags (Prince *et al*., 2005).

Collaborative studies conducted by NMFS and University of Miami scientists using PSATs while simultaneously conducting adult and larval sampling off the Dominican Republic in the spring of 2003 have revealed important information concerning white and blue marlin spawning locations as well as horizontal and vertical movements. Co-occurrence of larval blue marlin and white marlin in samples suggest that the two species share a spawning location in the vicinity of Punta Cana, Dominican Republic. Adult white and blue marlin caught in the area appear to have similar vertical and horizontal movement patterns in terms of time at depth, time at temperature, average horizontal displacement per day, net horizontal displacement, and directional dispersion (compass heading).

Displacements of seven white marlins tagged with PSATs ranged from 31.7 to 267.7 nm (58.7 to 495.8 km), while displacement of one blue marlin was 219.3 nm (406.2 km). In general, all marlin spent a high proportion of the monitoring time in the upper 25 m (82 ft) and at temperatures at or above 28°C (82°F). Minimum and maximum depth and temperatures monitored show that on most days marlin visited depths of 100 m (330 ft) or more, but generally stayed at these depths less that 10 percent of the time. Minimum temperatures ranged from 16.8° to 20.6°C (62.2° to 69°F), while maximum temperatures ranged from 28.2° to 30.0°C (82.7° to 86°F). Additional research in other areas of the Gulf of Mexico and U.S. Atlantic coast would help improve understanding and delineation of billfish EFH (Prince *et al*., 2005).

The characterization of adult movements and larval distribution in a potentially important spawning area is paramount for establishing improved management and rebuilding strategies for depressed Atlantic billfish stocks. However, more information on the distribution of reproduction and nursery areas and on adult movement patterns is needed to help managers make more informed decisions regarding conservation of the resource.

Scientists at VIMS have been involved with electronic tagging of blue and white marlin since 1999, some of which has been conducted in conjunction with the NOAA SEFSC. More recently, VIMS has deployed over 60 PSAT on white marlin during the past three years from both recreational sport boats and a commercial pelagic longline vessel to determine post-release survival (Prince *et. al*., 2005). In addition to this work, VIMS is also in the process of updating information regarding habitat preferences and vertical movements of white marlin using environmental data obtained from the PSAT work as well as other environmental data. Most of the work at VIMS, however, remains focused on the interactions of billfish with the various fisheries.

There are a few considerations and limitations of these data that reviewers should keep in mind as they look at EFH determinations (E. Prince pers. comm.). Inaccurate EFH maps for billfish can be created because of boat side misidentification of billfish, sexual dimorphism, and criteria used in defining groups can result in both under and overestimates and ultimately impact the accuracy of the maps. The CTS is the main source of data for most of the billfish EFH maps and it obtains size information of tagged, released, and recovered fish from constituents based mostly on boatside estimates of fish size. This approach introduces a significant amount of error.

In addition, most size estimates are made when the fish is underwater and the reflective index biases these estimates upwards by as much as 30 percent (E. Prince, pers. comm.).

Billfish are sexually dimorphic (size difference between sexes), with this being most severe for blue marlin. The maps provided in this amendment do not include a consideration of sexually dimorphic differences in size and thus the characterization of juvenile size limits on the maps may be quite different for male and female marlin. The tagging data only infrequently have recoveries that include gender, so separating the maps into males and females would not likely be practical, even though it would probably be more accurate (E. Prince, pers. comm.). Furthermore, the accuracy of the maps for defining juvenile marlin based on size could vary depending on the criteria used in this definition.

Data from the CTS, which account for a significant portion of the overall data points for billfish, were historically recorded only to the nearest degree, and did not include minutes or seconds. As a result, reviewers will notice that certain data points that reflect a high number of observations are lined up along major lines of latitude or longitude, both in the Gulf of Mexico and the Atlantic coast. This may be an artifact resulting from the way in which tagging locations were recorded rather than the true points of highest observed occurrence. Depending on reviewer comments received on this aspect of the data, NMFS may consider removing these data points during future considerations of EFH boundaries. Therefore, as a result of technical reviewer comments, several changes to EFH boundaries may be considered in the future. These include, but are not limited to, potential modifications of EFH boundaries for blue and white marlin for the reasons stated above (E. Prince, pers. comm.).

10.3.4 Sharks

Significant progress has been made in recent years in identifying habitat requirements and EFH for sharks. The proximity of nursery and pupping grounds to coastal areas has provided research opportunities that do not exist for other HMS that spawn much farther from shore. Sampling has increased in a number of different locations under the auspices of several different programs (Cooperative Atlantic States Shark Pupping and Nursery Survey (COASTSPAN), Cooperative Gulf of Mexico States Shark Pupping and Nursery Survey (GULFSPAN), and others). Considerable research has been devoted to determining the size ranges of the different shark life stages (neonate, juvenile, and adult). The size ranges for each species' lifestage used in this review as well as size ranges used in the 1999 FMP are presented in Table B.1, Appendix B. The table reflects new information and updates to the 1999 FMP size ranges. Based on these size ranges, the distribution data have been mapped for each species and life stage.

The 1999 FMP highlighted the importance of coastal nursery and pupping areas in maintaining viable shark populations. It also identified continued delineation of shark nurseries as a research priority. As a result, several studies and cooperative research projects aimed at improving NMFS' understanding of EFH and shark reproductive habitat requirements have been undertaken since the 1999 HMS FMP.

In 2002, the COASTPAN project initiated a synthesis document of information on shark nursery grounds along the U.S. Atlantic east coast and the Gulf of Mexico. Researchers from universities and state and Federal agencies in twelve different states from Massachusetts to Texas contributed information to the preliminary report (McCandless *et al*., 2002; McCandless et. al., 2005). This information was included in updates to EFH for several shark species in Amendment 1 to the FMP, and is being incorporated into the data for the current review. Results for the 2003 sampling year were compiled and synthesized, and the final report is currently under review. Participants in the 2003 COASTSPAN survey included the North Carolina Division of Marine Fisheries, the South Carolina Department of Natural Resources, Coastal Carolina University, the University of Georgia's Marine Extension Service and the University of Florida's Program for Shark Research. Researchers from the National Marine Fisheries Service's Apex Predators Program and the University of Rhode Island conducted the survey in Delaware Bay. A total of 3,698 sharks were sampled in the 2003 COASTSPAN survey. Juvenile sharks sampled, tagged and released during the survey were the Atlantic sharpnose, blacknose, blacktip, bonnethead, bull, dusky, finetooth, nurse, sandbar, sand tiger, scalloped hammerhead, silky, spinner, and tiger sharks, and also the smooth and spiny dogfish. Environmental parameters for each sampling location were also measured to indicate habitat preferences. There were a number of tag recaptures returned by fishery biologists and commercial and recreational fisherman in 2003 from sharks that were tagged by COASTSPAN cooperators in previous years.

A final synthesis document entitled "Shark Nursery Grounds of the Gulf of Mexico and the East Coast Waters of the United States" is currently under review for publication by the American Fisheries Society (AFS). It is a compilation of 20 individual papers documenting shark distributions in coastal habitats similar to the project described above, but expanded to include several new studies. This document provides valuable information for the possible modification or inclusion of additional shark EFH.

In 2003, NMFS initiated the GULFSPAN Survey to expand upon the Atlantic COASTSPAN Survey. States involved in the program during 2004, the second year of the program, include Florida, Mississippi, Alabama, and Louisiana. Sharks sampled, tagged, and released during the surveys included the Atlantic sharpnose, blacknose, blacktip, bonnethead, bull, finetooth, great hammerhead, sandbar, scalloped hammerhead, and spinner sharks. In addition, environmental parameters were measured qualitatively. The most abundant sharks included the Atlantic sharpnose, blacktip, and bull sharks. Results of this study are under review in the AFS synthesis document as well.

In Florida waters, most species captured were juveniles and young-of-the-year. Among sharks for all areas combined, the Atlantic sharpnose shark, a member of the small coastal shark (SCS) management group, was the most abundant shark captured, while the blacktip shark was the most abundant species captured in the LCS management group. The bonnethead shark was the second most abundant species captured in the SCS group and overall was the third most encountered species. The remaining species commonly captured in decreasing order of abundance were the finetooth, spinner, scalloped hammerhead, blacknose, and sandbar sharks. Other species infrequently caught were bull shark, great hammerhead shark, and the Florida smoothhound.

In Mississippi and Alabama waters, 75 percent of the sharks captured were immature. The blacktip shark was the most abundant species caught, followed by the Atlantic sharpnose, finetooth, and bull sharks. In Louisiana in the 2004 sampling season, most species captured were juveniles. The blacktip shark was the most abundant species caught, followed by the bull shark. A single adult specimen of the finetooth shark in addition to young-of-the-year Atlantic sharpnose shark was also collected in 2004.

New information on habitat preferences is also emerging from this study. Juvenile bonnethead sharks appear to prefer habitat dominated by seagrass (in northwest Florida) or mangroves (Louisiana), although these areas have not yet been identified as EFH. In areas where neither of these habitat types is available, juvenile bonnetheads are in very low numbers or absent (*i.e.* Mississippi Sound). Adult bonnethead sharks, however, are found in diverse habitats ranging from areas with a mud or sand bottom to areas dominated by seagrass. Evidence indicates bull sharks are found among the most diverse environmental conditions with salinities ranging from 15 ppt (in Louisiana and Mississippi) to 33 ppt (in northwest Florida), and over all habitat types. Within the Gulf of Mexico, most juvenile sandbar sharks are still predominately caught in the northwest portion while blacktip, finetooth, and Atlantic sharpnose sharks are found throughout all areas. Although bull sharks can be found over a variety of habitats, the areas of highest abundance are those adjacent to freshwater inflow.

Obtaining information regarding trophic relationships and feeding habits of sharks, also critical to understanding essential fish habitat, is another goal of the GULFSPAN program. A quantitative examination of feeding ecology from different areas can assist in understanding how juvenile sharks use nursery habitats, and which habitats are more valuable as nursery areas than others.

Mote Marine Laboratory’s CSR program is focusing on identifying and understanding shark nursery areas of the U.S. Gulf of Mexico and southeast Atlantic coasts. Through tagging studies, this program aims to characterize these nursery areas, obtain estimates of juvenile shark relative abundance, distribution, and growth rates, and reveal the movement patterns of these sharks. As of fall 2004, the CSR has collected data on 20,732 sharks of 16 species that utilize these coastal waters as pupping and nursery areas. More than half of the captured sharks (12,241) comprise neonate, young-of-the-year (YOY) or older juvenile sharks. The studies found that most pupping activity in the region occurs in the late spring and early summer, and the neonate and YOY animals inhabit the primary nurseries throughout the summer and into the fall. Typically, declining water temperatures in the fall are associated with the southward movement of sharks from these natal waters to warmer and in some cases offshore, winter nurseries. Tag returns of Year-1 sharks have demonstrated travel distances to winter nursery areas of at least 500 km (311 mi). Tag return data have further demonstrated annual cycles of philopatric behavior whereby juveniles of both large and small coastal species migrate back to their natal nurseries in spring and summer (Hueter and Tyminski, in review).

In the 1999 HMS FMP, the smallest size class of sharks was described as “neonates and early juveniles.” This definition has been modified to include primarily neonates and only small young-of-the-year sharks in order to better define and identify nursery areas. The total length cutoff for this size class is determined as the maximum embryo size in term females plus 10 percent. This criteria was used because it helps to eliminate some of the small one-year-old sharks that fall within the young-of the-year size range, making it easier to identify primary nursery areas (where pupping occurs and young-of-the-year are present). This criteria can also be more easily applied to other species given the lack of published data on growth rates for many species, especially during the first year. This modification should also better represent the habitat shift between primary nursery areas and secondary nursery areas (occupied by age 1+ sharks), although many species do overlap habitat use between these two size classes.

The middle size class designated in the 1999 HMS FMP, "late juveniles and subadults," has been renamed "juveniles". This size class includes all immature sharks from young juveniles to older or late juveniles. Some overlap between the "neonate and early juveniles" and the "adult" EFH areas may occur, depending on the species, due to the return to primary nursery areas by many juveniles, age 1+, and the developing conformity to adult migration patterns by late juveniles. As in the 1999 HMS FMP, the largest size class, "adults," still consists of mature sharks based on the size at first maturity for females of the species. Changes to the size range of the adult size class for some species have been made based on new information on the size at first maturity for females of those particular species.

As a result of technical reviewer comments, several changes to EFH boundaries may be considered in the future. These include, but are not limited to, potential modification of EFH boundaries for basking, hammerhead, white, bull, Caribbean reef, lemon, spinner, tiger, Atlantic sharpnose, blacknose, longfin mako, shortfin mako, oceanic whitetip, and thresher sharks (J. Castro and J. Carlson, pers. comm.). In summary, based on the preliminary examination of new information acquired since the original EFH identifications in 1999, and on comments from technical reviewers, modifications to some of the existing EFH descriptions and boundaries may be warranted. Any proposed modifications to existing boundaries, as well as consideration of any new HAPC areas, would be addressed in a subsequent document.

10.4 Threats to Essential Fish Habitat

10.4.1 Regulatory Requirements and Fishing Activities That May Affect EFH

Regulatory Requirement

The EFH regulations and the Magnuson-Stevens Act require the Regional Fishery Management Councils and NMFS, on behalf of the Secretary of Commerce, to minimize adverse effects on EFH from fishing activities to the extent practicable. Although NMFS is not taking any action to minimize fishing impacts in this FMP, NMFS may propose actions to minimize adverse effects from fishing in a subsequent rulemaking. Adverse effects from fishing may include physical, chemical, or biological alterations of the substrate, and loss of or injury to benthic organisms, prey species and their habitat, and other components of the ecosystem. Based on an assessment of the potential adverse effects of all fishing equipment types used within an area identified as EFH, NMFS must act if there is evidence that a fishing practice is having an a more than minimal and not temporary adverse effect on EFH.

The Magnuson-Stevens Act states that each FMP must contain an evaluation of the potential adverse effects of fishing on EFH designated under the FMP, including effects of each fishing activity regulated under the FMP or other Federal FMPs. This evaluation should consider the effects of each fishing activity on each type of habitat found within EFH. FMPs must describe each fishing activity, review and discuss all available relevant information (such as information regarding the intensity, extent, and frequency of any adverse effect on EFH; the type of habitat within EFH that may be affected adversely; and the habitat functions that may be disturbed), and provide conclusions regarding whether and how each fishing activity adversely affect EFH. The evaluation should also consider the cumulative effects of multiple fishing activities on EFH. The evaluation should list any past management actions that minimize potential adverse effects on EFH and describe the benefits of those actions to EFH. The evaluation should give special attention to adverse effects on habitat areas of particular concern and should identify for possible designation as habitat areas of particular concern any EFH that is particularly vulnerable to fishing activities. Additionally, the evaluation should consider the establishment of research closure areas or other measures to evaluate the impacts of fishing activities on EFH. In

This section includes an assessment of fishing gears and practices that are used in the Highly Migratory Species (HMS) fisheries to describe impacts to EFH and conservation recommendations or mitigation measures, as necessary.

10.4.2 Potential Impacts of HMS Fishing Activities on HMS and non-HMS EFH

Adverse effects from fishing may include physical, chemical, or biological alterations of the substrate, and loss or injury to benthic organisms, prey species and their habitat, and other components of the ecosystem. However, the degree to which fishing will impact EFH also depends on the substrate that makes up the EFH; certain substrates, such as complex coral reef habitat, will be more susceptible to damage due to fishing gears than will mud and/sand substrates or even the water column because of the extended time for habitat recovery. Below is a brief overview of HMS EFH followed by an assessment of HMS fishing gear impacts on both HMS EFH and non-HMS EFH.

10.4.2.1 HMS EFH Overview

From the broadest perspective, fish habitat is the geographic area where the species occurs at any time during its life. Habitat can be described in terms of location, physical, chemical and biological characteristics, and time. Ecologically, habitat includes structure or substrate that focuses distribution (*e.g.*, coral reefs, topographic highs, areas of upwelling, frontal boundaries, particular sediment types, or submerged aquatic vegetation) and other characteristics that are less distinct but are still crucial to the species' continued use of the habitat (*e.g.*, turbidity zones, salinity, temperature or oxygen gradients) (NMFS, 1999a).

Species use habitat for spawning, breeding, migration, feeding and growth, and for shelter from predation to increase survival. Spatially, habitat use may shift over time due to changes in life history stage, abundance of the species, competition from other species, and environmental variability in time and space. Species distributions and habitat use can be altered by habitat change and degradation resulting from human activities and impacts, or other factors. The type of habitat available, its attributes, and its function are important to species productivity, diversity and survival (NMFS, 1999a).

The role of habitat in supporting the productivity of organisms has been well documented in the ecological literature, and the linkage between habitat availability and fishery productivity has been examined for several fishery species. Because habitat is an essential element for sustaining the production of a species, the goals of FMPs must include maintaining suitable habitat for the considered species (NMFS, 1999a). However, the quantitative relationships between fishery production and habitat are very complex, and no reliable models currently exist. Accordingly, the degree to which habitat alterations have affected fishery production is unknown. In one of the few studies that have been able to investigate habitat fishery productivity dynamics, Turner and Boesch (1987) examined the relationship between the extent of wetland habitats in the Gulf of Mexico and the yield of fishery species dependent on coastal bays and estuaries. They found reduced fishery stock production following wetland losses, and stock gains following increases in the areal extent of wetlands. While most of the studies examined shrimp or menhaden productivity, other fisheries show varying degrees of dependence on particular habitats and likely follow similar trends. Accordingly, a significant threat facing fishery production is the loss of habitat due to natural and/or anthropogenic causes (NMFS, 1999a).

HMS utilizes diverse habitats that have been identified as essential to various life stages. Some billfish use both offshore and inshore habitats (*e.g.*, sailfish spawning in coastal habitats off southeastern Florida) (NMFS, 1999b). Many of the shark species use bays, estuaries and shallow coastal areas as crucial pupping and nursery areas (NMFS, 1999a). In most cases the neonates (newborn) and juveniles occupy different habitats than the adults. For example, neonate blacktip sharks are found in very shallow waters, juvenile blacktip sharks inhabit a variety of coastal habitats, and adults are found in both coastal and oceanic waters (Castro, 1993). There is little published information correlating life stages and migratory movements, and there are few descriptions correlating shark habitat use to physical habitat characteristics (but see McCandless *et al*., 2002). Parameters that could describe shark habitat are temperature, salinity, depth, dissolved oxygen, light levels, substrate, and food availability, although there are probably other important factors or requirements that remain unknown. Unlike certain reef or benthic fishes, it is difficult to draw definitive links between presence of a given species of HMS and characteristics of marine substrate (*i.e.*, sand, SAV, cobble) or types or marine ecosystems (*i.e.* mangroves, seagrass beds, and coral reefs). For example, Amendment 1 to the HMS FMP updated the EFH for juvenile (37-221 cm TL) nurse sharks as:

> *Shallow waters from the shoreline to the 25 m isobath off the east coast of Florida from south of Cumberland Island, GA (30.5 N) to the Dry Tortugas; also shallow waters from Charlotte Harbor, FL (26 N) to the north end of Tampa Bay, FL (28 N); also off Puerto Rico, shallow coastal waters out to the 25 m isobath from 66.5 W to the southwest tip of the island.*

In only a few cases for HMS are there particular bottom types that can be attributed to influencing the choice of habitats, *e.g.*, the bonnethead shark juvenile stages are associated with seagrass (Section 10.3.4). More typically, pelagic species (or life stages), such as the pelagic sharks, tuna and swordfish, are most often associated with areas of convergence or oceanographic fronts such those found over submarine canyons, the edge of the continental shelf, or the boundary currents (edge) of the Gulf Stream. Some species aggregate at frontal boundaries in the ocean, with floating objects (such as *Sargassum* for swordfish and billfish), or at bottom features such as the continental shelf break, submarine canyons, and even shipwrecks (NMFS, 1999b).

Occasionally, the aggregations form where a front or boundary lies above one of these bottom features. These aggregations are most likely associated with prime feeding grounds and, as such, these areas are identified as EFH. Although there is no substrate or hard structure in the traditional sense, these water column habitats can be characterized by their physical, chemical and biological parameters (NMFS, 1999a). The water column can be defined by a horizontal and vertical component. Horizontally, salinity gradients strongly influence the distribution of biota. Horizontal gradients of nutrients, decreasing seaward, affect primarily the distribution of phytoplankton and, secondarily, the organisms that depend on this primary productivity. Vertically, the water column may be stratified by salinity, oxygen content, and nutrients (SAFMC, 1998). The water column is especially important to larval transport. While the water column is relatively difficult to precisely define in terms of habitat characteristics, it is no less important since it is the medium of transport for nutrients and migrating organisms between estuarine, inshore, and offshore waters (SAFMC, 1998).

10.4.2.2 Impact of HMS Federally regulated gear on HMS and non-HMS EFH

Generally, HMS is associated with hydrographic structures of the water column, e.g., convergence zones or boundary areas between different currents. Because of the magnitude of water column structures and the processes that create them, there is little effect expected from the HMS fishing activities undertaken to pursue these animals. There are, however, some impacts that can be manifest on the biological or chemical characteristics of some of these sites, e.g., excess dead discards causing increased biological oxygen demand (BOD) (NMFS, 1999a). For fisheries in which gear does contact the substrate, there is certainly the potential for disturbance of the habitat. An analysis of the effects and the impacts they may have on the associated fisheries is complicated by the fact that scientists are not certain of the particular characteristics that draw the fish to these habitats (NMFS, 1999a).

Impacts of HMS fishing gears and practices were analyzed by examining published literature and anecdotal evidence of potential impacts or comparable impacts from other fisheries. An assessment was made based on this literature review of the gears and practices employed in HMS fisheries to determine whether these fishing activities cause adverse impacts on HMS EFH and non-HMS EFH (Table 10.1). The degree of impact from fishing activities depends in large part on the susceptibility of particular habitats to damage. EFH varies in its vulnerability to disturbance, as well as its rate of recovery. A variety of gears are used to target HMS species. Fishing gears that are only associated with the water column are expected to have no impact on the benthic environment and minimal to no impact to the pelagic environment (Table 10.1). However, fishing gears that interact with the benthic environment can have an impact, depending on the composition of the benthos. For example, due to its simple composition, sediments (*i.e.*, sand, mud) are impacted to a lesser degree than a complex coral reef under similar treatments. Coral reefs are composed of numerous structures forming species, with many that grow vertically into the water column (*e.g.*, sponges, stony corals, gorgonians) and create a greater surface area than sediments (Barnette, 2001). The vertical profile and increased surface area of coral reefs allow gear to easily become snagged or entangled, thus providing more opportunities for habitat to be impacted from fishing as compared to sediments (Barnette, 2001). While NMFS and the Councils have jurisdiction only in Federal waters of the exclusive economic zone under the Magnuson-Stevens Act, estuarine and nearshore waters are critical to various life stages of many organisms; numerous managed species utilize estuaries and bays for reproduction or during juvenile development (Barnette, 2001).

Since most HMS are pelagic species that are predominantly found in the mid- to upper water column of the neritic environments, most HMS gears are fished in the water column, as opposed to bottom tending gears such as trawls and dredges that are used to target bottom-dwelling or benthic species. The exception is bottom longline gear, which could potentially have adverse effects on HMS and non-HMS EFH (Table 10.1). Bottom longlines principally target large coastal sharks in the EEZ between Texas and Maine. Typically they are placed in sandy and muddy bottom habitats where expected impacts would be minimal to low (Barnette, 2001). The 1999 NMFS EFH Workshop categorized the impact of bottom longline gear on mud, sand, and hard-bottom as low (Barnett, 2001). Bottom longline may have some negative impact if gear is set in more complex habitats, such as hardbottom or coral reefs in the Caribbean or areas with gorgonians, or soft corals and sponges in the Gulf of Mexico (Barnette, 2001, NREFHSC, 2002; Morgan and Chuenpagdee, 2003). Bottom longline set with cable groundline or heavy monofilament with weights can damage hard or soft corals and potentially become entangled in coral reefs upon retrieval, resulting in coral breakage due to line entanglement. However, the extent to which bottom longline gear is fished in areas with coral reef habitat has not been determined. This gear type is similar to that employed in fisheries targeting reef fish in the Gulf of Mexico and South Atlantic regions.

One of the only studies available regarding the impact of bottom longline gears is from submersible observations of halibut longline gear off the southeast coast of Alaska (NPFMC, 1992). For example, halibut longline gear generally consists of 5/16- inch nylon or polyester rope as groundline with 3-4 foot long twine gangions (branch lines) spaced at 3-18 feet. To the degree that Caribbean, Gulf of Mexico, and Atlantic longlines differ in construction from the Alaska longlines, potential damage will also differ. Unlike Alaskan fisheries, Atlantic longlines can use cable or heavy monofilament with weights for groundline. In addition, the Alaskan marine ecosystem is much different from that in the Caribbean, Gulf of Mexico, and Atlantic Ocean in that it does not have tropical coral reefs. However, the Alaskan marine ecosystem does have sponges and other vertical relief, which makes it somewhat analogous to the Gulf of Mexico conditions, and therefore, may give some insight to the type of damage bottom longlines can cause. For instance, the shearing action of the longlines under tension would have similar results on sensitive vertical structure (Barnette, 2001). However, in instances where target species are attracted to the habitat due to hydrographic characteristics (*i.e.*, up-welling, convergences, etc.), the scale of impact from careless placement of bottom longlines is probably not of sufficient magnitude to affect the characteristics of the habitat. Bottom longline gear may have a detrimental effect on non-HMS EFH if it is placed in coral reefs, hard bottom or SAV habitats. However, bottom longline gear in HMS fisheries is primarily used in sandy and/or muddy habitats where it is expected to have minimal to low impacts.

Other HMS gears that contact the bottom are tuna traps and anchored gillnets. However, these are either so few in number that their expected impact is low (*i.e.*, there were only two tuna trap permit holders in 2004), or they are usually set in sand or mud areas where there is minimal to low impact on the benthic substrate, as is the case with anchored gillnets. In some cases, rod and reel or handlines (*i.e.*, "vertical gear") are used in areas with coral reefs and/or hardbottom, and impacts from these gears may include entanglement and minor degradation of benthic species from line abrasion and the use of weights (sinkers). Schleyer and Tomalin (2000) noted that discarded or lost fishing line appeared to entangle readily on branching and digitate corals and was accompanied by progressive algal growth. This subsequent fouling eventually overgrows and kills the coral, becoming an amorphous lump once accreted by coralline algae (Schleyer and Tomalin, 2000). Lines entangled among fragile coral may break delicate gorgonians and similar species. Due to the widespread use of weights over coral reef or hardbottom habitat and the concentration of effort over these habitat areas from recreational and commercial fishermen, the cumulative effect may lead to significant impacts resulting from the use of these gear types (Barnette, 2001).

Since most of HMS gears are fished in the water column, the impacts on EFH are generally considered negligible, minimal, or low. In other words, HMS gears do not affect the physical characteristics that define HMS EFH such as salinity, temperature, dissolved oxygen, and depth. Similarly, most HMS gears are not expected to impact other fisheries' EFH, with the possible exception of bottom longline, depending on where it is fished. Each of the HMS gears, the means by which they are fished, and their potential impacts on HMS and other species' EFH are described in the following section. However, no new management measures, and therefore no regulations, are proposed in this document. Rather, this document serves as an evaluation of fishing impacts on EFH and could help identify areas appropriate for HAPC and/or time/area closures in the future. NMFS is, however, currently exploring potential alternatives that could minimize the impacts of bottom longline, especially in areas of with hardbottom, hard and soft coral structure and sponges. For instance, bottom longlines used in the Caribbean reef fish fishery are typically 700 feet long. Potentially shorter longlines will likely do less habitat damage than longer longlines (Barnette, 2001). In addition, avoiding or reducing bottom longline effort on corals, gorgonians, or sponge habitat will minimize risk of habitat damage to these areas. The two following conservation recommendations are meant as precautionary measures, and should be used whenever possible in the event that impacts to coral reef or other hard bottom EFH habitat may be occurring but unverified: (1) fishers should take appropriate measures to identify bottom obstructions and avoid setting gear in areas where it may become entangled; and (2) if gear is lost, diligent efforts should be undertaken to recover the lost gear.

The Gulf of Mexico and Caribbean Fishery Management Councils (GOMFMC and CFMC, respectively) are evaluating the impacts of several gear types, including bottom longline, on EFH areas identified under their respective reef fish and coral reef fisheries (GOMFMC, 2004; CFMC, 2005). Specifically, both Councils are evaluating measures to minimize the impacts of bottom longline gear on coral reef habitat identified as EFH for several of their managed species in areas adjacent to the Dry Tortugas Marine Reserve in Florida and the Gramantic Banks off of Puerto Rico. However, NMFS would first need to assess the extent of HMS fishing effort, if any, in these areas. And, if those measures are finalized, NMFS will consider further rulemaking, as necessary, for the Atlantic shark fisheries, because there may be overlap in fishery participants (NMFS, 2003).

In summary, according to the best scientific information available to NMFS, NMFS concludes that most HMS gears are having minimal to no impact on HMS EFH or to other species' EFH.

Table 10.1. Impact assessment of HMS fishing gear on HMS and non-HMS EFH. '-' indicates that the gear type is not used in these habitat types. Habitat impacts are as follows: negligible = 0, low = +, medium = ++, high = +++, unknown=?, and a blank indicates not evaluated. Source: Symbols before the slash are from the Caribbean FEIS, 2004 (Table 3.15a). The symbols after the slash are taken from Barnette, 2001.

		Interactions Between HMS Fishing Gears and HMS and Non-HMS EFH *Habitat Type*					
		Estuarine/Inshore					**Offshore**
HMS Gear Type	Contacts Bottom	SAV	Coral Reef	Hard Bottom	Sand/Shell	Soft Bottom	HMS EFH Water column
Bandit Gear				/+			0
Bottom Longline	X	0/	+/	+/+	0/+	0/+	0
Handline		0/	+/	+/+	0/	0/	0
Harpoon							0
Gillnet, Anchored	X	+/+	++/	+/+	+/+	0/+	0
Gillnet /Strikenet							0
Pelagic Longline		0/0	0/0	0/0	0/0	0/0	0
Purse Seine, Tuna		0/?	0/	0/	0/+	0/+	0
Rod and Reel		0/	+/	+/+	0/	0/	0
Tuna Trap/Fish Weir	X	++/++	-	-	0/?	0/?	0

10.4.3 Potential Impacts of non-HMS Fishing Activities on HMS EFH

At this time, only limited information exists to relate fishing activities to habitat damage (Rester, 2000; Hamilton, 2000; Barnette, 2001; Johnson, 2002; NRC, 2002; Stevenson *et al.*, 2004), and the degree to which habitat damage affect fishery production to date is unknown (NMFS, 1999b). Therefore only a speculative, qualitative evaluation of the degree of impairment of the function of the habitat from fishing impacts can be made. This section provides an overview of potential impacts of non-HMS fishing gears on HMS EFH.

Nearly all HMS EFH is similarly defined according to the geographic boundaries of a given area as opposed to specific benthic habitat types that might be affected by fishing gears. However, for some species of sharks (blacktip, spinner, blacknose and finetooth) certain substrates, such as mud bottom and seagrasses in a specific area of Apalachicola and Apalachee Bay, have been identified as EFH (see Appendix B). For these specific coastal and estuarine habitats, there may be an impact on benthic habitats from bottom tending gears in state waters. Trawl fisheries that scrape the substrate, disturb boulders and their associated epiphytes or epifauna, re-suspend sediments, flatten burrows and disrupt seagrass beds have the potential to alter the habitat characteristics that are important for survival of early life stages of many targeted and non-targeted species. According to the GOMFMC (2004), bottom tending gears in this area consist of shrimp trawls and stone crab pots. The fishing impact index for these gears in this area was assessed as being low (based on habitat type and fishing effort from 2000-2001) (Figures 3.5.24 and 3.5.27b; GOMFMC, 2004). Thus, the adverse effects of these gears on these species' EFH are expected to be minimal. No other benthic habitat types have been identified as EFH for neonate or juvenile sharks (*i.e*., neonate and juvenile shark EFH has been designated based on depth, and/or isobath; Appendix B). Therefore, until such habitat types are identified and the degree of overlap and the extent to which habitat is altered by various bottom tending gears is known, NMFS cannot assess the impact of such gears on neonate and juvenile shark EFH.

The degree of impact and long-term habitat modification depends on the severity and frequency of the impacts as well as the amount of recovery time between impacts (Auster and Langton, 1999; Barnette, 2001). The extent to which particular parameters are altered by trawl gear is somewhat dependent on the configuration of the gear and the manner in which the gear is fished. Additional efforts are required to study HMS EFH areas that are fished for non-HMS species and identify fishing gears that impact these habitats in a "more than minimal and not temporary in nature" (50 CFR 600.815(a)(2)(ii)). In this regard, coordination efforts should be undertaken with the respective Councils to identify potential common areas. Research into the spatial distribution of these activities, the frequency of disturbance, and the short and long-term changes induced in the habitat are of primary importance. A better understanding of specific habitat types for HMS (the highest, most refined level of information available with which to identify EFH, and which is currently not available for HMS), and the habitat characteristics that influence the abundance of managed species within those habitats, is also needed in order to better understand the effects of fishing activities on habitat suitability for sharks (NMFS, 2003). The potential impacts of different gears with different habitats types are given in more detail in Barnette (2001), the Caribbean FEIS (2004), and Stevenson *et al*., (2004). Nonetheless, until specific habitat types are associated with HMS EFH, the degree to which these impacts will affect HMS EFH is currently unknown.

Besides altering the physical characteristics of EFH, other fisheries may remove prey species that make up the necessary biological components of HMS EFH. Many of these impacts have been addressed in other fishery management plans (*e.g.*, SAFMC, 1998; GMFMC, 1998) that focus on restricting the removal of attached species such as corals or kelp that provide essential structure in their respective habitats; however, for pelagic species other biological components must be considered.

As described in the EFH guidelines, loss of prey species may be an adverse effect on EFH and managed species because the presence of prey makes waters and substrate function as feeding habitat. Therefore, actions that reduce the availability of a major prey species, either through direct harm or capture, or through adverse impacts to the prey species' habitat that are known to cause a reduction in the population of the prey species, may be considered adverse effects on EFH if such actions reduce the quality of EFH. For example, bluefin tuna are opportunistic feeders that prey on a variety of schooling fish, including Atlantic herring in the Gulf of Maine. NMFS would need to determine the extent to which herring or other prey species contribute to bluefin tuna EFH, and whether the removal of a portion of herring would constitute a negative effect on bluefin tuna EFH. These types of analyses would be part of a follow up rulemaking in which changes to EFH boundaries may be proposed, potential impacts on EFH would need to be analyzed, and if necessary, measures to minimize adverse effects would be proposed. NMFS will continue to examine the importance of forage species on bluefin tuna and other HMS species EFH.

Besides direct harvest, prey species such as herring may be susceptible and sensitive to noise and schools are known to disperse when approached by vessels or when disturbed by mid-water nets or purse seines (NMFS, 2005). This disturbance could be interpreted as a potential impact on the pelagic habitat of juvenile or adult herring. The effect, however, is known to be temporary: schools of herring that are dispersed by vessels or mid-water trawls re-form quickly after passage of the boat or the net, within a matter of minutes (NMFS, 2005 are references therein). This may adversely affect the pelagic habitat for juvenile and adult herring, but the effects are minimal and temporary in nature and do not need to be minimized.

Some tuna and swordfish life stages have been found to be associated, or to co-occur, with floating mats of the brown algae, *Sargassum* spp. The mats are pelagic and are moved extensively by winds and currents. They are frequently found in convergence zones, windrows, or at current boundaries - areas that are EFH for many of the HMS life stages. Whether the floating mats serve as shelter, act as a source for aggregating prey (because of the abundance of prey species associated with them), serve as a means of camouflage, or serve some other biological function is not entirely clear. It is a biological component that may focus, particularly on the small scale, the distribution of certain life stages of tuna and swordfish, and it may need to be examined as EFH.

In summary, there are few anticipated impacts from other (*i.e.*, non-HMS) Federally regulated and non-Federally regulated gears on HMS EFH. Since most HMS EFH is defined as the water column or attributes of the water column (*i.e.*, temperature gradients, frontal boundaries, etc.), there are anticipated to be minimal or no cumulative impacts from non-HMS fishing gears. The only exceptions are nearshore and estuarine shark pupping grounds in the specific area described above and the effect of bottom tending gears in this area. Since benthic habitats have not been identified as EFH for neonate and juvenile sharks (with the exception of blacktip, spinner, finetooth and blacknose sharks in Apalachee Bay; see above), NMFS cannot currently assess the impact of these gears. If specific benthic habitat types (*i.e.*, SAV, mud, coral reefs, etc.) were to be identified as EFH for other sharks species, and the degree of overlap and impact of various bottom tending gears is known in these areas, NMFS would assess whether those types of gear have negative impacts on HMS EFH and determine if these impacts are more than minimal and not temporary in nature.

10.4.4 Federally Managed Fishing Activities

The following tables describe the comprehensive set of gears managed by HMS and by the different Fishery Management Councils in each of the regions. A brief description of all gears is given below in Section 10.4.6.

Table 10.2. A comprehensive list of all gear types used in HMS fisheries.

	HMS Fishery			
HMS Gear Type	**Shark**	**Tuna**	**Swordfish**	**Billfish**
Bandit Gear	X	X	X	
Harpoon		X	X	
Gillnet, Drift/Strikenet	X			
Longline, Bottom	X			
Longline, Pelagic	X	X	X	
Purse Seine, Tuna		X		
Trap		X		
Vertical Gear				
Handline	X	X	X	
Rod and Reel	X	X	X	X

The Federally managed gears for the Northeast region and their potential effects on HMS EFH are outlined in

Table 10.3. The Northeast region is comprised of the New England, Mid-Atlantic and South Atlantic Fishery Management Councils.

Table 10.3. Fishing gear types regulated in Federal waters of the Northeast region and their effects on HMS EFH. Habitat impact is as follows: minimal/negligible = 0. Source: Stevenson *et al*., 2004.

Northeast Region		***Effects of Fishing Gear on HMS EFH***
Gear Type	**Contacts Bottom***	**Water Column**
Bag Nets		0
Dredge, Clam	X	0
Dredge, Sea Scallop	X	0
Gill Nets, Drift		0
Gill Nets, Runaround		0
Gill Nets, Sink/Anchor	X	0
Gill Nets, Stake	X	0
Hand Harvest		0
Haul Seines, Long (Danish)	X	0
Longline (Bottom)	X	0
Longline (Pelagic)		0
Otter Trawl Bottom, Fish	X	0
Otter Trawl Bottom, Sea Scallop	X	0
Otter Trawl Bottom, Shrimp	X	0
Otter Trawl Midwater		0
Pots and Traps, Red Crab	X	0
Pots and Traps, Fish	X	0
Pots and Traps, Lobster Offshore	X	0
Purse Seine, Herring		0
Purse Seine, Tuna		0
Scottish Seine	X	0
Traps, Floating Fish		0

Northeast Region		*Effects of Fishing Gear on HMS EFH*
Gear Type	**Contacts Bottom***	**Water Column**
Trawl, Beam	X	0
Trawl Midwater, Paired		0
Troll Lines		0
Trot Lines		0
Vertical Gear		
Handline		0
Reel, Electric or Hydraulic		0
Rod and Reel		0

*At this time, there are no benthic habitats identified as HMS EFH that may be affected by bottom tending gears. In addition, there is insufficient evidence to indicate an impact of bottom tending gear on HMS EFH that is defined as the "water column."

The Federally managed gears for the Southeast region and their potential effects on HMS EFH are outlined in

Table **10.4**. The Southeast region is comprised of the Gulf of Mexico and the Caribbean Fishery Management Councils.

Table 10.4. Fishing gear types regulated in Federal waters in the Southeast region and their effects on HMS EFH. Habitat impact is as follows: minimal/negligible = 0. Source: Hamilton, 2000; Barnette, 2001; GOMFMC FEIS 2004.

Southeast Region		*Effects of Fishing Gear on HMS EFH*
Gear Type	**Contacts Bottom***	**Water Column**
Allowable Chemical	X	0
Bandit Gear		0
Dip Net		0
Gill/Trammel Nets		0
Hand Harvest		0
Longline (Bottom)	X	0
Slurp Gun		0
Snare		0
Spears/Powerheads		0
Trap, Lobster	X	0
Trap/Pots, Fish	X	0
[1]Trawl, Frame	X	0
[1]Trawl, Otter	X	0
Vertical Gear		0
Hook and Line		0
Rod and Reel		0

*At this time, there are no benthic habitats identified as HMS EFH that may be affected by bottom tending gears. In addition, there is insufficient evidence to indicate an impact of bottom tending gear on HMS EFH that is defined as the "water column."
[1]Not currently used in the Caribbean; however, potential exists for future use.

10.4.5 Non-Federally Managed Fishing Activities

The following tables describe the comprehensive set of gears that are not managed under fishery management plans.

Table 10.5 and Table 10.6 outline allowable gears that are used in state waters of the Northeast and Southeast regions. A brief description of all gears is given below in Section 10.4.6.

The non-Federally managed gears for the Northeast region and their potential effects on HMS EFH are outlined in. The Atlantic States Marine Fisheries Commission manages non-Federal fisheries in the New England, Mid-Atlantic and South Atlantic regions.

Table 10.5. Non-FMP Fishing Gear in the Northeast region and their effects on HMS EFH. Habitat impact is as follows: minimal/negligible = 0. Source: Stevenson *et al*., 2004.

Northeast RegionNon-FMP **(state waters)**		***Effects of Fishing Gear on HMS EFH***
Gear Type	**Contacts Bottom***	**Water Column**
Cast Nets		0
Clam Kicking	X	0
Diving		0
Dredge, Conch	X	0
Dredge, Crab	X	0
Dredge, Mussel	X	0
Dredge, Oyster,	X	0
Dredge, Bay Scallop	X	0
Dredge, Sea Urchin	X	0
Fyke and Hoop Nets, Fish	X	0
Hand Hoes	X	0
Pots and Traps, Conch	X	0
Pots and Traps, Blue and Blue Peeler Crab	X	0
Pots and Traps, Eel	X	0
Pots and Traps, Lobster Inshore	X	0
Pounds Nets, Crab	X	0
Pound Nets, Fish	X	0
Purse Seines, Menhaden		0
Rakes	X	0
Scrapes	X	0
Seines, Haul-Beach	X	0
Seines, Haul-Long	X	0
Seines, Haul-Long (Danish)	X	0
Seines, Stop	X	0
Spears		0
Tongs and Grabs, Oyster	X	0
Tongs Patent, Clam	X	0
Tongs Patent, Oyster	X	0
Trawl, Otter-Crab	X	0
Weirs	X	0

*At this time, there are no benthic habitats identified as HMS EFH that may be affected by bottom tending gears. In addition, there is insufficient evidence to indicate an impact of bottom tending gear on HMS EFH that is defined as the "water column."

The non-Federally managed gears for the Southeast region and their potential effects on HMS EFH are outlined in Table 10.6. The Gulf States Marine Fisheries Commission manages non-federal fisheries in the Gulf of Mexico and the Caribbean regions.

Table 10.6. Non-FMP Fishing Gear in Southeast region: Effects of other fishing gear on HMS EFH. Habitat impact is as follows: minimal/negligible = 0. Source: Hamilton, 2000; Barnette, 2001; GOMFMC, 2004.

***Southeast Region Non-FMP* (state waters)**		***Effects of Fishing Gear on HMS EFH***
Gear Type	**Contacts Bottom***	**Water Column**
Barrier Net	X	0
Cast Net		0
Crab Scrapes	X	0
Dredge-Oyster	X	0
Drop Net		0
Lampara Net		0
Longline (Pelagic)	X	0
Purse Seine		0
Rakes and Tongs	X	0
Seine, Beach	X	0
Traps/Pots- Crab	X	0
Trawl, Skimmer	X	0
Vertical Gear		
Handline		0

*Currently the only benthic habitat types identified as EFH for neonate sharks are in Apalachee Bay off the Florida Panhandle. In this area, neonate blacktip, spinner, finetooth and blacknose sharks have been associated with mud or seagrass areas. The GOMFMC (2004) has determined that bottom tending gears (shrimp trawls and crab pots) have a low impact on these habitat types in this area. In addition, there is insufficient evidence to indicate an impact of bottom tending gear on HMS EFH that is defined as the "water column."

10.4.6 Description of Fishing Gears

Fishing gears that are dragged over the seabed or through the water column are called mobile gear (*e.g.*, trawls, dredges, and purse seines), whereas gear that remains stationary are called static gear (nets, traps, and longlines). Unless otherwise noted, gear descriptions were taken from Stevenson *et al*., (2004).

Bottom Tending, Mobile Gear

<u>Trawls</u>

Trawls are classified by their function, bag construction, or method of maintaining the mouth opening. Function may be defined by the part of the water column where the trawl operates (*e.g.*, bottom), by the species that it targets, or the composition of the bottom (smooth versus rough and soft versus hard) (Hayes, 1983). There is a wide range of otter trawl types used in the Northeast and Southeast as a result of the diversity of fisheries prosecuted and bottom types encountered in the region. For instance, trawls target flatfish, crabs scallops, lobsters, and shrimp in the Northeast (Stevenson *et al.*, 2004), and shrimp, calico scallops, flounder and butterfish in both state and Federal waters of the Gulf of Mexico (GFMC FDEIS 2004).

Otter Trawls - Bottom trawls are towed at a variety of speeds, but average about 5.5 km/hr (3 knots or nmi/hr). There are three components of the otter trawl that come in contact with the sea bottom: the doors, the ground cables and bridles, which attach the doors to the wings of the net, and the sweep (or foot-rope) which runs along the bottom of the net mouth.

The traditional otter board door is a flat, rectangular wood structure with steel fittings and a steel "shoe" along the bottom that prevents the bottom of the door from damage and wear as it drags over the bottom. Other types include the V-type (steel), polyvalent (steel), oval (wood), and slotted spherical otter board (steel) (Sainsbury, 1996). It is the spreading action of the doors resulting from the angle at which they are mounted that creates the hydrodynamic forces needed to push them apart. Steel cables are used to attach the doors to the wings of the net. The ground cables run along the bottom from each door to two cables (the "bridle") that diverge to attach to the top and bottom of the net wing. The bottom portion of the bridle also contacts the bottom.

On smooth bottoms, the sweep may be a steel cable weighted with chain, or may be merely rope wrapped with wire. On rougher bottoms, rubber discs ("cookies") or rollers are attached to the sweep to assist the trawl's passage over the bottom (Sainsbury, 1996). There are two main types of sweep used in smooth bottom in New England (Mirarchi, 1998). In the traditional chain sweep, loops of chain are suspended from a steel cable, with only 2-3 links of the chain touching bottom. Streetsweeper gear is much heavier in the water due to the use of steel cores in the brush components. Roller sweeps and rockhoppers are used on irregular bottom (Carr and Milliken, 1998). Vertical rubber rollers rotate freely and are as large as 14.5 cm (36 inches) in diameter. In New England, the rollers have been largely replaced with "rockhopper" gear that uses larger fixed rollers and are designed to "hop" over rocks as large as 1 meter in diameter. Small rubber "spacer" discs are placed in between the larger rubber discs in both types of sweep.

In the Northeast, flatfish are primarily targeted with a mid-range mesh flat net that has more ground rigging and is designed to get the fish up off the bottom. A high rise or fly net with larger mesh is used to catch demersal fish that rise higher off the bottom than flatfish (NREFHSC, 2002). Crabs, scallops, and lobsters are also harvested in large mesh bottom trawls. Small mesh bottom trawls are used to capture northern and southern shrimp, whiting, butterfish and squid and usually employ a light chain sweep. Small-mesh trawls are designed, rigged, and used differently than large-mesh fish trawls and are used to catch northern shrimp in the Gulf of Maine. In the Southeast, bottom trawl fisheries target demersal species throughout the U.S. Atlantic Ocean (Barnette, 2001, National Academy of Sciences, 2002). These activities are managed under Federal fishery management plans.

Beam Trawls - The beam trawl is much like an otter trawl except the net is spread horizontally by a steel beam that runs the horizontal width of the net rather than with otter boards. The net is spread vertically by heavy steel trawl heads that generally have skid-type devices with a heavy shoe attached (Sainsbury, 1996). It is believed that beam trawls are not currently used in the Northeast United States (NREFHSC, 2002). A few beam trawls were used in the 1970s to catch monkfish, but the fishery was unsuccessful. In the mid 1990's, a number of boats off New Bedford, MA used what were referred to as beam trawls, but the gear more closely resembled a scallop dredge rather than the traditional, European beam trawls. There are a few boats that are currently recorded as using beam trawls in the NMFS fishery landings database, but it is believed these were most likely mis-characterized and are actually otter trawls being deployed from the side of the vessels (NREFHSC, 2002). In the Southeast, beam trawls are used for monkfish, shrimp, and other demersal species. These trawls are also used for scientific sampling as the fixed mouth opening allows for consistent benthic sampling. In Florida, roller frame trawls are used to harvest bait shrimp primarily in state waters (National Academy of Sciences, 2002). These activities are managed under Federal fishery management plans.

<u>Dredges</u>

Most dredges are used for clams, oysters and scallops and are primarily used in the Northeastern region.

Hydraulic Clam Dredge - Hydraulic clam dredges have been used in the surfclam (*Spisula solidissima*) fishery and in the ocean quahog (*Arctica islandica*) fishery. These dredges are highly sophisticated and are designed to: 1) be extremely efficient (80 to 95% capture rate); 2) produce a very low bycatch of other species; and 3) retain very few undersized clams (NREFHSC, 2002). The typical dredge is 3.7 m (12 feet) wide and about 6.7 m (22 feet) long and uses pressurized water jets to wash clams out of the seafloor. Towing speed at the start of the tow is about 4.5 km/hr (2.5 knots or nmi/hr) and declines as the dredge accumulates clams. The water jets penetrate the sediment in front of the dredge to a depth of about 20 - 25 cm (8 - 10 inches), depending on the type of sediment and the water pressure. The water pressure that is required to fluidize the sediment varies from 50 pounds per square inch (psi) in coarse sand to 110 psi in finer sediments. The objective is to use as little water as possible since too much pressure will blow sediment into the clams and reduce product quality. The "knife" (or "cutting bar") on the leading bottom edge of the dredge opening is 14 cm (5.5 inches) deep for surfclams and 8.9 cm (3.5 inches) for ocean quahogs. This activity is managed under a Federal fishery management plan.

Dredges are not fished in clay, mud, pebbles, rocks, coral, large gravel greater than one half inch, or seagrass beds (NREFHSC, 2002). In the soft-clam (*Mya arenaria*) fishery, the dredge manifold and blade are located just forward of an escalator, or conveyor belt, that carries the clams to the deck of the vessel. These vessels are restricted to water depths less than one-half the length of the escalator and are typically operated from 15 m (49 ft) vessels in water depths of 2-6 m (6.6 - 20 ft) (DeAlteris, 1998). The escalator dredge is not managed under Federal fishery management plans.

Quahog Dredge - Ocean quahogs are also harvested in eastern Maine coastal waters using a non-hydraulic dredge that is essentially a large metal cage on skis with 15 cm (6 inch) long teeth projecting at an angle off the leading bottom edge. Maine state regulations limit the length of the cutter bar to 91 cm (36 inches). The teeth rake the bottom and lift the quahogs into the cage. This fishery takes place in small areas of sand and sandy mud found among bedrock outcroppings in depths of 9 to > 76 m (30 - 250 ft) in state and Federal coastal waters. These dredges are used on smaller boats, about 9 - 12 m long (30 to 40 ft) and are pulled through the seabed using the boat's engine (NREFHSC, 2002). This fishery is managed under the MAFMC Surf Clam and Ocean Quahog FMP (MAFMC).

Sea Scallop Dredges - The New Bedford (or "chain sweep") dredge is the primary gear used in the Northeast U.S. sea scallop (*Placopecten magellanicus*) fishery and is very different than scallop dredges utilized in Europe and the Pacific because it is a toothless dredge. The forward edge of the New Bedford dredge includes the cutting bar, which rides above the surface of the substrate, creating turbulence that stirs up the substrate and kicks objects (including scallops) up from the surface of the substrate into the bag. Shoes on the cutting bar are in contact with and ride along the substrate surface (NREFHSC, 2002). A sweep chain is attached to each shoe and to the bottom of the ring bag (Smolowitz, 1998). The bag is made up of metal rings with chafing gear on the bottom and twine mesh on the top, and drags on the substrate when fished. Tickler chains run from side to side between the frame and the ring bag and, in hard bottom, a series of rock chains run from front to back to prevent large rocks from getting into the bag (Smolowitz, 1998). New Bedford dredges are typically 4.3 m (14 feet) wide; two of them are towed by a single vessel at speeds of 4 to 5 knots. Chain sweep dredges used along the Maine coast are smaller. In the Northeast region, scallop dredges are used in high and low energy sand environments, and high energy gravel environments. This activity is managed under a Federal fishery management plan.

<u>Other Non-Hydraulic Dredges</u>

Oyster or Crab Dredge/Scrape/Mussel Dredge - The oyster dredge is a toothed dredge consisting of a steel frame 0.5-2.0 m (1.6 -6.6 ft) in width, a tow chain or wire attached to the frame, and a bag to collect the catch. The bag is constructed of rings and chain-links on the bottom to reduce the abrasive effects of the seabed, and twine or webbing on top. The dredge is towed slowly (<1 m/sec) in circles, from vessels 7 to 30 m (23 - 98 ft) in length (DeAlteris, 1998). Crabs are harvested with dredges similar to oyster dredges. Stern-rig dredge boats (approximately 15 m (49 ft) in length) tow two dredges in tandem from a single chain warp. The dredges are equipped with 10 cm (4 inch) long teeth that rake the crabs out of the bottom. (DeAlteris, 1998). The toothed dredge is also used for harvesting mussels (Hayes, 1983). These dredging activities are not managed under Federal fishery management plans.

Bay Scallop Dredge - Bay scallops usually reside on the bottom. The bay scallop dredge may be 1 to 1.5 m (3.3 - 4.9 ft) wide and about twice as long. The simplest bay scallop dredge can be just a mesh bag attached to a metal frame that is pulled along the bottom. For bay scallops that are located on sand and pebble bottom, a small set of raking teeth are set on a steel frame, and skids are used to align the teeth and the bag (Sainsbury, 1996). This dredging activity is not managed under Federal fishery management plans.

Sea Urchin Dredge - Similar to a simple bay scallop dredge, the sea urchin dredge is designed to avoid damaging the catch. It has an up-turned sled-like shape at the front that includes several leaf springs tied together with a steel bar. A tow bail is welded to one of the springs and a chain mat is rigged behind the mouth box frame. The frame is fitted with skids or wheels. The springs act as runners, enabling the sled to move over rocks without hanging up. The chain mat scrapes up the urchins. The bag is fitted with a codend for ease of emptying. This gear is generally only used in waters up to 100 m (330 ft) deep (Sainsbury, 1996). This dredging activity is not managed under Federal fishery management plans.

Clam "Kicking" - Clam kicking is a mechanical form of hard clam harvest practiced in North Carolina, which involves the modification of boat engines so that the propeller is directed downwards instead of backwards (Guthrie and Lewis, 1982). In shallow water the propeller wash is powerful enough to suspend bottom sediments and clams into a plume in the water column, which allows them to be collected in a trawl net towed behind the boat (Stephan *et al.*, 2000). This activity is not managed under a Federal fishery management plan.

<u>Seines</u>

Haul Seines - Haul seining is a general term describing operations where a net is set out between the surface and seabed to encircle fish. It may be undertaken from the shore (beach seining), or away from shore in the shallows of rivers, estuaries or lakes (Sainsbury, 1996). Seines typically contact the sea bottom along the lead line. Additionally the net itself may scrape along the bottom as it is dragged to shore or the recovery vessel. This activity is not managed under a Federal fishery management plan.

Beach Haul Seines - The beach seine resembles a wall of netting of sufficient depth to fish from the sea surface to the seabed, with mesh small enough that the fish do not become gilled. A floatline runs along the top to provide floatation and a leadline with a large number of weights attached ensures that the net maintains good contact with the bottom. Tow lines are fitted to both ends. The use of a beach seine generally starts with the net on the beach. One end is pulled away from the beach, usually with a small skiff or dory, and is taken out and around and finally back in to shore. Each end of the net is then pulled in towards the beach, concentrating the fish in the middle of the net. This is eventually brought onshore as well and the fish are removed. This gear is generally used in relatively shallow inshore areas (Sainsbury, 1996). This activity is not managed under a Federal fishery management plan.

Long Haul Seines - The long haul seine is set and hauled in shallow estuarine and coastal areas from a boat typically 15 m (49 ft) long. The net is a single wall of small mesh webbing less than 5 cm (2 inches), and is usually greater than 400 m (1440 ft) in length and about 3 m (9.8 ft) in depth. The end of the net is attached to a pole driven into the bottom, and the net is set in a circle so as to surround fish feeding on the tidal flat. After closing the circle, the net is hauled into the boat, reducing the size of the circle, and concentrating the fish. Finally, the live fish are brailed or dip-netted out of the net. (DeAlteris, 1998). This activity is not managed under Federal fishery management plans

Stop Seines - These are seines that are used in coastal embayments to close off the opening to a small cove or bight. This method is used in Maine to harvest schools of juvenile herring (Everhart and Youngs, 1981). This activity is not managed under a Federal fishery management plan.

Danish and Scottish Seines - The Danish seine is a bag net with long wings, that includes long warps set out on the seabed, enclosing a defined area. As the warps are retrieved, the enclosed area (a triangle) reduces in size. The warps dragging along the bottom herd the fish into a smaller area, and eventually into the net mouth. The gear is deployed by setting out one warp, the net, then the other warp. On retrieval of the gear, the vessel is anchored. This technique of fishing is aimed at specific schools of fish located on smooth bottom. In contrast to Danish seining, if the vessel tows ahead while retrieving the gear, then this is referred to as Scottish seining or fly-dragging. This method of fishing is considered more appropriate for working small areas of smooth bottom, surrounded by rough bottom. This activity is managed under a Federal fishery management plan.

Bottom Tending, Static Gear

<u>Pots</u>

Pots are portable, rigid devices that fish and shellfish enter through small openings, with or without enticement by bait (Everhart and Youngs, 1981; Hubert, 1983). They are used to capture lobsters, crabs, black sea bass, eels and other bottom dwelling species seeking food or shelter (Everhart and Youngs, 1981; Hubert, 1983). Traps and pots are weighted to rest on the bottom, marked with buoys at the surface, and are sometimes attached to numerous other trap and one long line called a trot line. Pot fishing can be divided into two general classifications: (1) inshore potting in estuaries, lagoons, inlets and bays in depths up to about 75 m (250 ft) and; (2) Offshore potting using larger and heavier vessels and gear in depths up to 730 m (2400 ft) or more (Sainsbury, 1996).

In the Southeast region, pots are used for a number of fish and invertebrates. In certain areas of the Gulf of Mexico and Caribbean, due to their use to harvest species associated with coral and hardbottom habitat, traps and pots have been identified to impact and degrade habitat (Barnette, 2001).

Lobster Pots - Lobster pots are typically rectangular and are divided into two sections, the chamber and the parlor. The chamber has an entrance on both sides of the pot and is usually baited. Lobsters then move to the parlor via a tunnel (Everhart and Youngs, 1981). Escape vents are installed in both areas of the pot to minimize the retention of sub-legal sized lobsters (DeAlteris, 1998). Lobster pots are fished as either 1) a single pot per buoy (although two pots per buoy are used in Cape Cod Bay, and three pots per buoy in Maine waters), or 2) a "trawl" or line with up to 100 pots. According to NREFHSC (2002) important features of lobster pots and their use are the following:

- About 95% of lobster pots are made of plastic - coated wire.
- Floating mainlines may be up to 7.6 m (25 ft) off bottom.
- Sinklines are sometimes used where marine mammals are a concern – neutrally buoyant lines may soon be required in Cape Cod Bay.
- Soak time depends on season and location - usually 1-3 days in inshore waters in warm weather, to weeks in colder waters.
- Offshore pots are larger (more than 1 m (4 ft) long) and heavier (~ 100 lb or 45 kg), with an average of ~ 40 pots/trawl and 44 trawls/vessel. They have a floating mainline and are usually deployed for a week at a time.
- There has been a three-fold increase in lobster pots fished since the 1960's, with more than four million pots now in use.
- Although the offshore component of the fishery is regulated under Federal rules, American lobster is not managed under a Federal fishery management plan.

Fish Pots - Fish pots are similar in design to lobster pots. They are usually fished singly or in trot lines of up to 25 pots, in shallower waters than the offshore lobster pots or red crab pots. Pots may be set and retrieved 3-4 times/day when fishing for scup (NREFHSC, 2002). Wire-mesh fish traps are one of the principal fishing gears used in coral reef areas in the Caribbean (Appledorn *et al.*, 2000). This activity is managed under a Federal fishery management plan.

Hagfish pots (40 plastic gallon barrels) are fished in deep waters, on mud bottoms. Cylindrical pots are typically used for capturing eels in Chesapeake Bay, however, half-round and rectangular pots are also used and all are fished in a manner similar to that of lobster pots (Everhart and Youngs, 1981). Hagfish and eel activities are not managed under a Federal fishery management plan.

Crab Pots - Crabs are often fished with pots consisting of a wire mesh. A horizontal wire partition divides the pot into an upper and lower chamber. The lower chamber is entered from all four sides through small wire tunnels. The partition bulges upward in a fold about 20 cm (8 inches) high for about one third of its width. In the top of the fold are two small openings that give access to the upper chamber (Everhart and Youngs, 1981).

Crab pots are always fished as singles and are hauled by hand from small boats, or with a pot hauler on larger vessels. Crab pots are generally fished after an overnight soak, except early and late in the season (DeAlteris, 1998). These pots are also effective for eels (Everhart and Youngs, 1981). This activity is not managed under a Federal fishery management plan.

Deepsea red crab pots are typically wood and wire traps 1.2 m by 0.75 m (48 by 30 inches) with top entry. Pots are baited and soak for about 22 hours before being hauled. Currently, vessels are using an average of 560 pots in trawls of 75- 180 pots per trawl along the continental slope at depths from 400 to 800 m (1300 - 2600 ft). These vessels are typically 25 -

41 m (90 - 150 ft) in length. Currently there are about 6 vessels engaged in this fishery (NEFMC, 2002). This activity is managed under a Federal fishery management plan.

Traps

A trap is generally a large-scale device that uses the seabed and sea surface as boundaries for the vertical dimension. The gear is installed at a fixed location for a season, and is passive, as the animals voluntarily enter the gear. Traps are made of a leader or fence, that interrupts the coast parallel migratory pattern of the target prey, a heart or parlor that leads fish via a funnel into the bay or trap section that serves to hold the catch for harvest by the fishermen. The non-return device is the funnel linking the heart and bay sections (DeAlteris, 1998).

Fish Pound Nets - Pound nets are constructed of netting staked into the seabed by driven piles (Sainsbury, 1996). Pound nets have three sections: the leader, the heart, and the pound. The leader (there may be more than one) may be as long as 400 m (1300 ft) and is used to direct fish into the heart(s). One or more hearts are used to further funnel fish into the pound and prevent escapement. The pound may be 15 m (49 ft) square and holds the fish until the net is emptied. These nets are generally fished in waters less than 50 m (160 ft) deep. Pound nets are also used to catch crabs. This activity is not managed under a Federal fishery management plan.

Fyke and Hoop Nets - Constructed of wood or metal hoops covered with netting, hoop nets are 2.5 to 5 m (8.2 - 16 ft) long, “Y-shaped” nets, with wings at the entrance and one or more internal funnels to direct fish inside, where they become trapped. Occasionally, a long leader is used to direct fish to the entrance. Fish are removed by lifting the rear end out of the water and loosening a rope securing the closed end. These nets are generally fished to about 50 m (160 ft) deep (Sainsbury, 1996). A common fyke net is a long bag mounted on one or several hoops which keep the net from collapsing as well as provide an attachment for the base of the net funnels to prevent the fish from escaping. This gear is used in shallow water and extensively in river fisheries (Everhart and Youngs, 1981). This activity is not managed under a Federal fishery management plan.

Bag Nets – Bag nets are large nets that are kept vertically open by a frame, usually constructed of wood, and are held horizontally stretched by the water current. Bag nets are fished usually in deep water and are held in position by floats and anchors. This activity is not managed under a Federal fishery management plan.

Shallow Floating Traps - In New England, much of the shoreline and shallow subtidal environment is rocky and stakes cannot be driven into the bottom. Therefore, the webbing of these traps is supported by floats at the sea surface, and held in place with large anchors. These traps are locally referred to as “floating traps.” The catch, design elements, and scale of these floating traps is similar to pound nets (DeAlteris, 1998). The floating trap is designed to fish from top to bottom, and is built especially to suit its location. The trap is held in position by a series of anchors and buoys. The net is usually somewhat “T-shaped,” with the long portion of the net (the leader net) designed to funnel fish into a box of net at the top of the “T.” The leader net is often made fast to a ringbolt ashore (Sainsbury, 1996). This activity is not managed under a Federal fishery management plan.

Weirs - A weir is a simple maze that intercepts species that migrate along the shoreline. Brush weirs are used in the Maine sardine/herring fishery. These are built of wooden stakes and saplings driven into the bottom in shallow waters. The young herring encounter the lead, which they follow to deeper water, finally passing into an enclosure of brush or netting. The concentrated fish are then removed with a small seine (Everhart and Youngs, 1981). This activity is not managed under a Federal fishery management plan. However, there are a few Federal permits for incidental catch of bluefin tuna using weirs in the Northeast. This activity is managed under a Federal fishery management plan.

Sink Gill Nets and Bottom Longlines

Sink/Anchor Gill Nets - Individual gill nets are typically 91 m (300 ft) long, and are usually fished as a series of 5-15 nets attached end-to-end. Gill nets have three components: leadline, webline and floatline. Fishermen are now experimenting with two leadlines. Leadlines used in New England are ~65 lb (30 kg)/net, but in the Middle Atlantic leadlines may be heavier. Weblines are monofilament, with the mesh size depending on the target species. Nets are anchored at each end, using materials such as pieces of railroad track, sash weights, or Danforth anchors, depending on currents. Anchors and leadlines have the most contact with the bottom. Some nets may be tended several times/day, (*e.g.*, when fishing for bluefish in the Middle Atlantic). For New England groundfish, frequency of tending ranges from daily to biweekly (NREFHSC, 2002).

Trammel Net - A trammel net is made up of two or more panels suspended from a float line and attached to a single lead line. The outer panel(s) are of a larger mesh size than the inner panel. Fish swim through the outer panel and hit the inner panel, which carries it through the other outer panel, creating a bag and trapping the fish. Smaller and larger fish become wedged, gilled, or tangled (Barnette, 2001). Trammel nets are primarily used in state waters, though they are an authorized gear in the Caribbean for both the spiny lobster and shallow water reef fish fisheries.

Strikenets - Vessels fishing in a strikenet fashion used nets 364.8 meters long, 30.4 meters deep, and with mesh size 22.9 cm. Strikenetting consists of using an additional smaller, second vessel to actively set the net around a school of sharks. These nets are sometimes referred to runaround drift gillnets. Nets used for sharks in the southeast region are typically 456 to 2,280 meters long and 6.1 to 15.2 meters deep, with stretched mesh from 12.7 to 22.9 cm. This fishery is currently prohibited in the state waters off South Carolina, Georgia, and Florida, Texas and Louisiana thereby forcing some of these vessels to operate in deeper waters under Federal jurisdiction, where gillnets are less effective. The entire process (set to haulback) takes approximately 9 hours (Carlson and Baremore, 2002). These activities are managed under Federal fishery management plans.

Stake Gill Nets - Generally a small boat is used inshore so that a gill net is set across a tidal flow and is lifted at slack tide to remove fish. Wooden or metal stakes run from the surface of the water into the sediment and are placed every few meters along the net to hold it in place. When the net is lifted, the stakes remain in place. These nets are generally fished from the surface to about 50 meters deep (Sainsbury, 1996). These activities are not managed under Federal fishery management plans.

Runaround Drift Gillnet – see “Strikenets”.

Bottom Longlines - Longlining for bottom species on continental shelf areas and offshore banks is undertaken for a wide range of species including cod, haddock, dogfish, skates, and various flatfishes (Sainsbury, 1996). A 9.5 m (31 ft) vessel can fish up to 2,500 hooks a day with a crew of one and double that with two crew members. Mechanized longlining systems fishing off larger vessels up to 60 m (195 ft) can fish up to 40,000 hooks per day (Sainsbury, 1996).

In the Northeast, up to six individual longlines are strung together, for a total length of about 460 m (1500 ft), and are deployed with 20-24 lb (9 - 11 kg) anchors. The mainline is parachute cord or sometimes stainless steel wire. Gangions (lines from mainline to hooks) are 38 cm (15 inches) long and 1-2 m (3-6 ft) apart. The mainline, hooks, and gangions all come in contact with the bottom. Circle hooks are potentially less damaging to habitat features than other hook shapes. These longlines are usually set for only a few hours at a time (NREFHSC, 2002). Longlines used for tilefish are deployed in deep water, may be up to 40 km (25 miles) long, are stainless steel or galvanized wire, and are set in a zig-zag fashion (NREFHSC, 2002).

The Southeast bottom longline fishery targets both large coastal sharks (LCS) and small coastal sharks (SCS) of sharks as well as reef fish. Bottom longline is the primary commercial gear employed in the LCS and SCS fisheries in all regions. Gear characteristics vary by region, but in general, an approximately ten-mile long bottom longline, containing about 600 hooks, is fished overnight. Skates, sharks, or various finfishes are used as bait. The gear typically consists of a heavy monofilament mainline with lighter weight monofilament gangions. Some fishermen may occasionally use a flexible 1/16 inch wire rope as gangion material or as a short leader above the hook. This activity is managed under a Federal fishery management plan.

Trot Lines – see “Pots” section

Pelagic Gear

Mid-Water Otter Trawl - The mid-water trawl is used to capture pelagic species that school between the surface and the seabed throughout the water column. The mouth of the net can range from 110 m to 170 m (360 - 560 ft) wide and requires the use of large vessels (Sainsbury, 1996). Successful mid-water trawling requires the effective use of various electronic aids to find the fish and maneuver the vessel while catching them (Sainsbury, 1996). This activity is managed under a Federal fishery management plan. This gear is not expected to have contact with or impacts upon bottom habitats.

Paired Mid-Water Otter Trawl - Pair-trawling is used by smaller vessels, which herd small pelagics such as herring and mackerel into the net (Sainsbury, 1996). Large pelagic species are also harvested with a huge pelagic pair trawl towed at high speed near the surface. The nets have meshes exceeding 10 m (33 ft) in length in the jibs and first belly sections, and reduce to cod-end mesh sizes of 20 cm (8 inches) (DeAlteris, 1998). This activity is managed under a Federal fishery management plan. This gear is not expected to have contact with or impacts upon bottom habitats.

Purse Seines - Purse seines are very efficient for taking pelagic schooling species. The purse seine is a continuous deep ribbon of web with corks on one side and leads on the other. Rings are fastened at intervals to the lead line and a purse line runs completely around the net through the rings (Everhart and Youngs, 1981). One end of the net is fastened to the vessel and the other end to a skiff. The vessel then encircles a school of fish with the net, the net pursed and hauled back to the vessel. Purse seines vary in size according to the vessel size, the size of the mesh, the species sought and the depth to be fished. Tuna seines are nearly one kilometer (0.6 miles) long and fish from 55 - 640 m (180 - 2100 ft) (Everhart and Youngs, 1981). Due to the large depth of the net for tuna purse seines, they have been shown to contact and interact with the sea bottom when fishing in some shallow water locations such as Massachusetts Bay and vicinity (NMFS, 2001). Purse seines are also utilized to harvest menhaden in the Gulf and South Atlantic. Purse seines in the Gulf menhaden fishery frequently interact with the bottom, resulting in sediment re-suspension (Barnette, 2001). Currently there are only five vessels permitted to fish for tunas with purse seine gear. This activity is managed under a Federal fishery management plan.

Lampara Net - The lampara net has a large central bunt, or bagging portion, and short wings. The buoyed float line is longer than the weighted lead line so that as the lines are hauled, the wings of the net come together at the bottom first, trapping the fish. As the net is brought in, the school of fish is worked into the bunt and captured. In the Florida Keys, a modified lampara net is used to harvest baitfish near the top of the water column. The wing is used to skim the water surface as the net is drawn in and fish are herded into the pursing section to be harvested with a dip net. This activity is not managed under a Federal fishery management plan. This gear is not expected to have contact with or impacts upon bottom habitats.

Drift Gill Nets - Gillnets operate principally by wedging and gilling fish, and secondarily by entangling (DeAlteris, 1998). The nets are a single wall of webbing, with float and lead lines. Drift gillnets are designed so as to float from the sea surface and extend downward into the water column and are used to catch pelagic fish. In this case the buoyancy of the floatline exceeds the weight of the leadline. Drift gillnets may be anchored at one end or set-out to drift, usually with the fishing vessel attached at one end (DeAlteris, 1998). This activity is managed under a Federal fishery management plan. This gear is not expected to have contact with or impacts upon bottom habitats.

Pelagic Longline Gear - The pelagic or subsurface longline is a technique directed mostly towards tunas, swordfish, sailfish, dolphin (dorado), and sharks. The gear is typically set at depths from the surface to around 330 m (1100 ft). The gear can also be set with a main line hanging in arcs below the buoy droplines to fish a band of depths (Sainsbury, 1996). The gear is set across an area of known fish concentration or movement, and may be fished by day or night depending upon the species being sought (Sainsbury, 1996). The length of the mainline can vary up to108 km (67 miles) depending on the size of the vessel. If the mainline is set at a fixed depth, then the leader or gangion lengths vary from 2-40 m (6.6 - 130 ft), so as to ensure the hooks are distributed over a range of depths (DeAlteris, 1998). If a line-shooter is used to set the mainline in a catenary shape with regard to depth, then the gangions are usually a single minimal length, but are still distributed by depth (DeAlteris, 1998). Each gangion typically contains a baited hook and chemical night-stick to attract the fish. Traditional or circle hooks may be used.

Swordfish vessels typically fish 20 to 30 hooks per 1.6 km (one mile) of mainline between 5 and 54 km (3 - 34 miles) in length (Sainsbury, 1996). This activity is managed under a Federal fishery management plan. This gear is not expected to have contact with or impacts upon bottom habitats.

Troll Lines - Trolling involves the use of a baited hook or lure maintained at a desired speed and depth in the water (Sainsbury, 1996). Usually, two to four or more lines are spread to varying widths by the use of outrigger poles connected to the deck by hinged plates. Line retrieval is often accomplished by means of a mechanized spool. Each line is weighted to reach the desired depth and may have any number of leaders attached, each with a hook and bait or appropriate lure. This gear is generally fished from the surface to about 20 meters (Sainsbury, 1996). This activity is managed under a Federal fishery management plan. This gear is not expected to have contact with or impacts upon bottom habitats.

Other Gear

Rakes - A bull rake is manually operated to harvest hard clams and consists of a long shaft with a rake and basket attached. The length of the shaft can be variable but usually does not exceed three times the water depth. The length and spacing of the teeth as well as the openings of the basket are regulated to protect juvenile clams from harvest (DeAlteris, 1998). Rakes are typically fished off the side of a small boat. This activity is not managed under a Federal fishery management plan.

Tongs - Tongs are a more efficient device than rakes for harvesting shellfish. Shaft-tongs are a scissor-like device with a rake and basket at the end of each shaft. The fisherman stands on the edge of the boat and progressively opens and closes the baskets on the bottom gathering the shellfish into a mound. The tongs are closed a final time, brought to the surface, and the catch emptied on the culling board for sorting. The length of the shaft must be adjusted for water depth. Oysters are traditionally harvested with shaft tongs in water depths up to 6 m (21 ft), with shaft tongs 8 m (29 ft) in length (DeAlteris, 1998).

Patent tongs are used to harvest clams and oysters and are opened and closed with a drop latch or with a hydraulic ram and require a mechanized vessel with a mast or boom and a winch (DeAlteris, 1998). Patent tongs are regulated by weight, length of teeth, and bar spacing in the basket. This activity is not managed under a Federal fishery management plan.

Line Fishing/Handgear/Vertical Gear

Handlines/Hook and Line - The simplest form of hook and line fishing is the hand line. It consists of a line, sinker, leader and at least one hook. The line is usually stored on a small spool and rack and can vary in length. The line varies in material from a natural fiber to synthetic nylon. The sinkers vary from stones to cast lead. The hooks are single to multiple arrangements in umbrella rigs. An attraction device must be incorporated into the hook, usually a natural bait and artificial lure (DeAlteris, 1998). Although not typically associated with bottom impacts, this gear can be fished in such as manner so as to hit bottom and bounce or be carried by currents until retrieved. This activity is managed under a Federal fishery management plan.

Electric or Hydraulic Reel - Mechanized line hauling systems have been developed to allow more lines to be worked by smaller crews and use electrical or hydraulic power to work the lines on the spools or jigging machines (Sainsbury, 1996). These reels, often termed bandits, are mounted on the vessel bulwarks and have a spool around which the mainline is wound (Sainsbury, 1996). Each line may have a number of branches and baited hooks, and the line is taken from the spool over a block at the end of a flexible arm. This gear is used to target several species of groundfish, especially cod and pollock, and it has the advantage of being effective in areas where other gears cannot be used. Jigging machine lines are generally fished in waters up to 600 m (2000 ft) deep (Sainsbury, 1996). This gear may also have the ability to contact the bottom depending upon the method selected to fish. This activity is managed under a Federal fishery management plan.

Bandit Gear – see "Electric or Hydraulic Reel."

Rod and Reel – Rod and reel consists of a handheld fishing rod with a manually or electronically operated reel attached. This gear may have the ability to contact the bottom. This activity is managed under a Federal fishery management plan.

Hand Hoes - Intertidal flats are frequently harvested for clams and baitworms using hand-held hoes. These are short handled rake-like devices, which are often modified gardening tools (Creaser *et al.*, 1983). Baitworm hoes have 5 to 7 tines, 21 to 22 cm (8.3 - 8.7 ft) in length for bloodworms and 34 to 39 cm (13 – 15 inches) for sandworms. Clam hoes in Maine typically have 4 to 5 tines, 15 cm (6 inches) long (Wallace, 1997). This activity is not managed under a Federal fishery management plan.

Diving - By either free diving or using SCUBA, divers collect crustaceans, mollusks and some reef fish in shallow water. Most often a support vessel is used to transport the diver(s) to the fishing site and carry the landings to port. In deeper waters, helmet diving systems are used and the diver is tethered to the vessel with air pumped from the surface. This method is most often used by sea urchin divers and some lobster divers. Divers normally use small rakes or hoes to scrape creatures off rocks or dig them out of the seabed. Generally, the catch is placed in bags, which are either towed to the surface by the boat or floated to the surface using an air source and a lift bag. Divers rarely work deeper than about 20 m (66 ft) (Sainsbury, 1996). This activity is not managed under a Federal fishery management plan.

Spears/Powerheads - Spears were initially hand-held, then thrown, then placed in launching devices including cross-bows, spear guns for divers, etc. Spears with long shafts (gigs) are used by fishermen in small boats at night in the Carolina Sounds for flounder, through the ice for eels in New England bays, and by divers for fish in coastal waters (DeAlteris, 1998). In the Southeast, reef fish such as grouper and snapper, as well as pelagic species such as dolphin and mackerel, are targeted by divers (Barnette, 2001). Commercial divers sometimes employ a shotgun shell known as powerhead at the shaft tip. This method is commonly used to harvest large species such as amberjack (Barnette, 2001). This activity is not managed under a Federal fishery management plan.

Harpoon – A harpoon consists of a pointed dart or iron attached to the end of a line several hundred feet in length, the other end of which is attached to a flotation device. Harpoon gear is attached to a pole that is propelled only by hand and not by mechanical means. This activity is managed under a Federal fishery management plan.

Slurp Guns - Slurp guns are self-contained, handheld devices that capture tropical fish by pulling in seawater that contains target fish. These are typically used on hard bottom substrates and over coral reefs in state and Federal waters. This activity is not managed under a Federal fishery management plan.

Allowable Chemical - Collectors of live tropical reef fish commonly employ anesthetics such as quinaldine (Barnette, 2001). Quinaldine (2-methy quinoline, C10H9N) is the cheapest and most available of several substituted quinolines (Goldstein, 1973). This activity is not managed under a Federal fishery management plan.

Barrier Net - Barrier nets are used in conjunction with small tropical nets or slurpguns to collect tropical aquarium species. The net is deployed to surround a coral head or outcropping and may or may not have a pocket or bag that fish are "herded" into for capture. Barrier nets may be utilized by tropical fish collectors in both state and Federal waters (Barnette, 2001). This activity is not managed under a Federal fishery management plan.

Snare - Recreational divers pursuing spiny lobster often use a long, thin pole that has a loop of coated wire on the end called a snare. The loop is placed around a lobster that may be residing in a tight overhang or other inaccessible location, and then tightened by a pull toggle at the base of the pole in order to capture and extract the lobster (Barnette, 2001). This activity is managed under a Federal fishery management plan.

Dip net/Bully Net - Widely utilized to catch baitfish, crabs, or lobster, varieties of dip nets consist of a long pole with a bag of netting of varying mesh size that are lowered into the water. Dip nets may also be employed to capture tropical reef fish, though these utilize a short handle and very fine mesh. Additionally, landing nets or hand bully nets used to capture lobster can be considered a form of dip net. Varieties of dip nets may be used both in state and Federal waters (Barnette, 2001). This activity is managed under a Federal fishery management plan.

Cast Net - Used to capture baitfish and shrimp, cast nets are circular nets with a weighted skirt that is thrown over a schooling target. Cast nets are primarily used in shallow areas such as estuaries, though they may be used to catch baitfish offshore in Federal waters (Barnette, 2001). This activity is managed under a Federal fishery management plan.

Drop Net - Drop nets are closed-bottom square or circular nets having a square or circular frame attached to the open top of the net. A series of lines run from points on the frame to a single hand line. This allows the net to be lowered into the water to sit flat on the bottom. Bait can be attached to the bottom of the net or dropped onto the water's surface above the net to attract the target species. When the desired species is on or above the net, it is hauled up quickly, presumably capturing the organism. The drop net is also known by the name "lift net", which seems more appropriate. These nets are generally fished in calmer waters with relatively flat sand or mud bottoms in estuarine settings, and are used mostly to catch crabs (GULF FEIS, 2004). This activity is not managed under a Federal fishery management plan.

10.4.7 Summary

In summary, NMFS concludes that most HMS gears are having minimal to no impact on HMS EFH or to other species' EFH. Bottom longline gear is one of the only gear types that could have a detrimental effect on the benthic environment, especially if placed in coral reef, hard bottom or SAV habitats. However, bottom longline gear in HMS fisheries is primarily used in sandy and/or muddy habitats where it is expected to have minimal to low impacts. NMFS is aware of actions being taken by the Gulf and Caribbean Fishery Management Councils to minimize fishing impacts in specific habitat areas described earlier. To provide consistency between the Council regulations and HMS regulations, NMFS may consider similar alternatives to prohibit HMS gears in those areas in a subsequent rulemaking. In addition, NMFS will continue to collect the necessary data to determine if these potential adverse effects from bottom longline could be more than minimal and not temporary on non-HMS EFH in a future document.

In general, NMFS has not detected adverse effects from non-HMS fishing gears on HMS EFH. As outlined in Section 10.4.2.1, most HMS EFH is defined as the water column or attributes of the water column (*i.e.*, temperature gradients, frontal boundaries, etc.). Therefore, there are little anticipated cumulative impacts that rise above the threshold of more than minimal and not temporary from non-HMS fishing gears. The only exceptions are nearshore and estuarine shark pupping grounds where bottom tending gears (*i.e.*, trawls and dredges) that dramatically altered the benthic environment and overlap with the EFH of these species may have some negative impact on their EFH. However, habitat types associated with these species' EFH, the degree of overlap between the various bottom tending gears and these species' EFH, the extent to which the habitat is altered by these gears, and the impact these gears have on the EFH are all currently unknown. As data becomes available to NMFS, NMFS will make the determination of whether or not these gears have adverse effects on HMS EFH and if those effects are more than minimal and not temporary in nature.

10.5 Non-fishing Impacts to EFH

The EFH regulations require that FMPs identify non-fishing related activities that may adversely affect EFH of managed species, either quantitatively or qualitatively, or both. In addition, the regulations require that Federal agencies consult with NMFS on all actions, or proposed actions that are permitted, funded, or undertaken by the agency, and that may adversely affect EFH. NMFS must then recommend conservation measures to conserve and enhance EFH by avoiding, minimizing, mitigating, or otherwise offsetting the adverse effects to EFH.

Broad categories of activities that may adversely affect HMS EFH include, but are not limited to: (1) actions that physically alter structural components or substrate, *e.g.*, dredging, filling, excavations, water diversions, impoundments and other hydrologic modifications; (2) actions that result in changes in habitat quality, *e.g.*, point source discharges; (3) activities that contribute to non-point source pollution and increased sedimentation; (4) introduction of potentially hazardous materials; or (5) activities that diminish or disrupt the functions of EFH. If these actions are persistent or intense enough, they can result in major changes in habitat quantity as well as quality, conversion of habitats, or in complete abandonment of habitats by some species.

HMS EFH has been identified in estuarine, coastal, and offshore waters. Estuaries and coastal embayments have been identified as particularly important shark nursery areas, while offshore waters contain important spawning and feeding areas for HMS. All of these waters are at one time or another used by humans for a variety of purposes that often result in degradation of these and adjacent habitats, posing threats, either directly or indirectly, to the biota they support. These effects, either alone in combination with (cumulative) effects from other activities within the ecosystem, may contribute to the decline of some species or degradation of the habitat. In some cases such effects may be demonstrated, but they are often difficult to quantify.

Pollutants (*e.g.*, heavy metals, oil and grease, excess nutrients, improperly treated human and animal wastes, pesticides, herbicides and other chemicals) can be introduced into the aquatic environment through a number of routes, including point sources, non-point sources, and atmospheric deposition. These contaminants have been demonstrated to affect finfish and invertebrates by altering the growth, visual acuity, swimming speed, equilibrium, feeding rate, response time to stimuli, predation rate, spawning seasons, migration routes, and resistance to disease and parasites. In addition to the introduction of contaminants that cause direct effects on animal physiology, point and non-point source discharges also affect essential habitat characteristics such as temperature, pH, dissolved oxygen, salinity, and other parameters that affect habitat suitability for individuals, populations, and communities. The synergistic effects of multiple discharge components such as heavy metals and various chemical compounds are not well understood but are increasingly the focus of research efforts. More subtle effects of contaminants, such as endocrine disruption in aquatic organisms and reduced ability to reproduce or compete for food, are also being identified and investigated (Hanson *et al*., 2003).

Non-point source runoff, which is often difficult to detect, may have a more significant impact on coastal water quality, resulting in tighter controls on point source discharges. Activities that tend to increase the input of contaminants to aquatic environments through non-point sources include coastal development, urbanization, certain agriculture and silviculture practices, marina and port development, commercial and recreational boating, and hydromodification. Related activities, such as the use of septic systems and improper disposal or treatment of wastes, can also contribute biological contaminants. Many of these activities can result in large quantities of pesticides, nutrients, and bacteria or pathogens in coastal waters. Excess nutrification is one of the greatest sources of coastal water contamination. Nutrient enrichment can lead to noxious algal blooms, fish kills, and oxygen depletion (as hypoxic or anoxic events). Researchers have found reduced or stressed fisheries populations to be common in areas where hypoxia occurs (Hanson *et al*., 2003).

As required under the EFH regulations, the following discussion identifies non-fishing activities that have the potential to adversely affect HMS EFH. In many cases these activities are regulated under particular statutory authorities. As long as they are regulated within those guidelines, their potential to adversely affect EFH may be reduced, although not necessarily eliminated. Many of the standards that are used to regulate these activities are based on human health needs and do not consider long-term impacts on fish and fish habitats. Additionally, if the activity fails to meet, or is operated outside of, its permitted standards, it may adversely affect EFH. The EFH regulations require NMFS and the Councils to identify actions with the potential to adversely affect EFH, including its biological, chemical and physical characteristics. The EFH regulations also recommend the examination of cumulative impacts to EFH, as it is possible that multiple permitted actions, while each is operating within its respective regulatory bounds, may, when combined with others, cause adverse impacts to EFH. The following sections encompass a broad range of activities so as to ensure that their potential to adversely affect HMS EFH has been identified.

The review of habitat use undertaken for HMS identified both benthic and water column habitats in coastal, estuarine and offshore areas as EFH, although in many cases the particular habitat characteristics that influence species habitat use are not clearly understood or identified. Many of these factors appear to be related to water quality (*e.g.*, temperature, salinity, dissolved oxygen). Therefore, water quality degradation has been a primary focus in this section. When analyzing the impacts that water quality changes can have on HMS EFH, it is important to examine all habitats. EFH for HMS includes offshore areas, but even these distant habitats are affected by actions that originate in coastal habitats (both terrestrial and aquatic) and adjacent estuaries. Many of the HMS aggregate over submarine canyons or along river plumes; these physiographic features can serve as conduits for currents moving from inshore out across the continental shelf and slope, while carrying and redistributing contaminants from the nearshore realm to offshore habitats. Until the precise zones of influence from various river and coastal discharges can be delineated, a precautionary approach should be taken in order to protect the integrity of HMS EFH and the sustainability of the HMS fisheries.

10.5.1.1 Land-based Activities That May Impact HMS EFH

Coastal Development

Coastal development activities include urban, suburban, commercial, and industrial construction, along with development of corresponding infrastructure. These activities may result in erosion and sedimentation, dredging and filling (see following sub-section), point and non-point source discharges of nutrients, chemicals, and cooling water into streams, rivers, estuaries and ocean waters. Industrial point source discharges result in the contamination of water and degradation of water quality by introducing organics and heavy metals or altering other characteristics such as pH and dissolved oxygen. Improperly treated sewage treatment effluent has been shown to produce changes in water quality as a result of chlorination and increased contaminant loading, including solids, phosphorus, nitrogen and other organics, and human pathogens and parasites. Non-point source pollution - that which results from land runoff, atmospheric deposition, drainage, groundwater seepage, or hydrologic modification - results in the deposition of pathogens, nutrients, sediments, heavy metals, oxygen demanding substances, road salts, hydrocarbons and other toxics.

Coastal development can also lead to the destruction of coastal wetlands, resulting in the elimination of protective buffer zones that serve to filter sediments, nutrients, and contaminants - such as heavy metals and pesticides - that are transported to the coastal zone in ground and surface waters. In addition, hydrological modifications associated with coastal development alter freshwater inflow to coastal waters, resulting in changes in salinity, temperature, and nutrient regimes, and thereby contributing to further degradation of estuarine and nearshore marine habitats. The variety of pollutants and the severity of their effects from coastal development activities depend upon a number of factors, such as the nature of the construction, physical characteristics of the site involved, and proximity of the pollutant source to the coastline. However, all of these factors ultimately serve to degrade estuarine and coastal water quality to some degree in terms of dissolved oxygen levels, salinity concentrations, and contaminants. The result can be losses of important flora and fauna.

Agriculture (and Silviculture)

Cropland, livestock rangeland, and commercial nursery grounds can be connected to coastal waters and inland tributaries. Agricultural and silvicultural practices can affect estuarine, coastal and marine water quality through nutrient enrichment and chemical contamination from animal wastes, fertilizers, pesticides and other chemicals via non-point source runoff or via drainage systems that serve as conduits for contaminant discharge into natural waterways. Pesticides can adversely affect EFH through direct toxicological impact on the health or performance of exposed fish, an indirect impairment of the productivity of aquatic ecosystems, and a loss of aquatic vegetation that provides physical shelter for fish. In addition, uncontrolled or improper irrigation practices can contribute to non-point source pollution, and may exacerbate contaminant flushing into coastal waters. Major impacts also include nutrient over-enrichment with subsequent deoxygenation of surface waters; algal blooms, which can also produce hypoxic or anoxic conditions and stimulation of toxic dinoflagellate growth. Excessively enriched waters often will not support fish, and may also not support food web assemblages and other ecological assemblages needed to sustain desirable species and populations. Agricultural activities also increase soil erosion and associated sediment transport in adjacent water bodies, resulting in high turbidity. Many of these same concerns may apply to silviculture as well.

10.5.1.2 Coastal and Offshore Activities That May Impact HMS EFH

Dredging and Disposal of Dredge Material

Dredging operations occur in estuaries, nearshore areas, and offshore in order to maintain certain areas for activities such as shipping, boating, construction of infrastructure (*e.g.*, offshore oil and gas pipelines), and marine mining. Disposal of the dredged material takes place in designated open water disposal areas, often near the dredge site. These operations result in negative impacts on the marine environment. Of particular concern regarding HMS EFH is the temporary degradation of water quality due to the resuspension of bottom materials, resulting in water column turbidity, potential contamination due to the release of toxic substances (metals and organics), and reduced oxygen levels due to the release of oxygen-consuming substances (*e.g.*, nutrients, sulfides). Even with the use of approved practices and disposal sites, ocean disposal of dredged materials is expected to cause environmental harm since contaminants will continue to be released, and localized turbidity plumes and reduced oxygen zones may persist.

Aquaculture and Mariculture

Aquaculture is an expanding industry in the United States, with most facilities located in farmland, tidal, intertidal and coastal areas. Aquaculture related impacts that adversely affect the chemical and biological nature of coastal ecosystems include the discharge of excessive waste products and the release of exotic organisms and toxic substances. Problems resulting from the introduction of food and fecal wastes may be similar to those resulting from certain agricultural activities. However, greater nutrient input and localized eutrophic conditions are currently the most probable environmental effects of aquaculture activities. Extremely low oxygen levels and fish kills, of both natural stocks and cultured fish, have been known to occur in impounded wetlands where tidal and wind circulation are severely limited and the enclosed waters are subject to solar heating. In addition, there are impacts related to the dredging and filling of wetlands and other coastal habitats, as well as other modifications of wetlands and waters through the introduction of pens, nets, and other containment and production devices.

Navigation

Navigation-related threats to estuarine, coastal, and offshore environments that have the potential to affect HMS EFH include navigation support activities such as excavation and maintenance of channels (including disposal of excavated sediments) which result in the elevation of turbidity and resuspension of contaminants; construction and operation of ports, mooring and cargo facilities; construction of ship repair facilities; and construction of channel stabilization structures such as jetties and revetments. In offshore locations the disposal of dredged material is the most significant navigation related threat, resulting in localized burial of benthic communities and degradation of water quality. In addition, threats to both nearshore and offshore waters are posed by vessel operation activities such as the discharge and spillage of oil, other hazardous materials, trash and cargo, all of which may result in localized water quality degradation and direct effects on HMS, especially eggs, larvae and neonates that may be present. Wakes from vessel operation may also exacerbate shoreline erosion, effecting habitat modification and potential degradation.

Marinas and Recreational Boating

Marinas and recreational boating are increasingly popular uses of coastal areas. As marinas are located at the water's edge, there is often no buffering of associated pollutants released into the water column. Impacts caused by marinas include lowered dissolved oxygen, increased temperatures, bioaccumulation of pollutants by organisms, toxic contamination of water and sediments, resuspension of sediments and toxics during construction, eutrophication, change in circulation patterns, shoaling, and shoreline erosion. Pollutants that result from marina activities include nutrients, metals including copper released from antifouling paints, petroleum hydrocarbons, pathogens, and polychlorinated biphenyls. Also, chemicals commonly used to treat timber used for piers and bulkheads (*e.g.*, creosote, copper, chromium, and arsenic salts) are introduced into the water. Other potential impacts associated with recreational boating are the result of improper sewage disposal, fuel and oil spillage, cleaning operations, and disposal of fish waste. Propellers from boats can also cause direct damage to multiple life stages of organisms, including eggs, larvae/neonates, juveniles and adults; destratification; elevated temperatures, and increased turbidity and contaminants by resuspending bottom materials.

Marine Sand and Minerals Mining

Mining for sand (*e.g.*, for beach nourishment projects), gravel, and shell stock in estuarine and coastal waters can result in water column effects by changing circulation patterns, increasing turbidity, and decreasing oxygen concentrations at deeply excavated sites where flushing is minimal. Ocean extraction of mineral nodules is a possibility for some non-renewable minerals now facing depletion on land. Such operations are proposed for the continental shelf and the deep ocean proper. Deep borrow pits created by mining may become seasonally or permanently anaerobic. Marine mining also elevates suspended materials at mining sites, creating turbidity plumes that may move several kilometers from these sites. Resuspension of sediments can affect water clarity over wide areas, and could also potentially affect pelagic eggs and larvae. In addition, resuspended sediments may contain contaminants such as heavy metals, pesticides, herbicides, and other toxins.

Offshore Oil and Gas Operations

Offshore oil and gas operations (exploration, development, production, transportation and decommissioning) pose a significant level of potential threat to marine, coastal and estuarine ecosystems. Exploration and recovery operations may cause substantial localized bottom disturbance. However, more pertinent to HMS is the threat of contaminating operational wastes associated with offshore exploration and development, the major operational wastes being drilling muds and cuttings and formation waters. In addition, there are hydrocarbon products, well completion and work-over fluids, spill clean-up chemicals, deck drainage, sanitary and domestic wastes, ballast water, and the large volume of unrefined and refined products that must be moved within offshore and coastal waters.

Potential major contaminants used in oil and gas operations may be highly saline; have low pH; contain suspended solids, heavy metals, crude oil compounds, and organic acids; or may generate high biological and chemical oxygen demands. Also, accidental discharges of oil - crude, diesel and other oil products - and chemicals can occur at any stage of exploration, development, or production, the great majority of these being associated with product transportation activities. Blowouts and associated oil spills can occur at any operational phase when improperly balanced well pressures result in sudden, uncontrolled releases of petroleum hydrocarbons. To remove fixed platforms, explosives are frequently used. All of these activities result in harmful effects on marine water quality as well as the biota in the vicinity.

In the Gulf of Mexico, Outer Continental Shelf (OCS) oil and gas operations are extending to deeper and deeper waters, throughout which HMS are known to range. Locations such as the De Soto Canyon area in the northern Gulf and the Blake Plateau north of the Bahamas repeatedly appear in the analysis of HMS EFH as highly productive areas important to many of these species. Oil and gas production in these areas should be discouraged because of the potential impact on HMS EFH in these areas.

Considerable documentation exist that highlights the benefits of offshore production platforms as artificial reefs that attract numerous species of fishes, including HMS. It is likely that the attraction of these species to the platforms increases the potential for exposure to contaminants they may release into the aquatic environment.

Liquid Natural Gas Development

Liquefied natural gas, or LNG, is natural gas in its liquid form. By cooling natural gas to minus 259° F (-161° C), it becomes a clear, colorless, odorless liquid. LNG is neither corrosive nor toxic. Natural gas is primarily methane, with low concentrations of other hydrocarbons, water, carbon dioxide, nitrogen, oxygen and some sulfur compounds. During the process known as liquefaction, natural gas is cooled below its boiling point, removing most of these compounds. The remaining natural gas is primarily methane with only small amounts of other hydrocarbons. LNG weighs less than half the weight of water so it will float if spilled on water.

Ships unload LNG at specially designed terminals where the LNG is pumped from the ship to insulated storage tanks at the terminal. LNG is also converted back to gas at the terminal, which is connected to natural gas pipelines that transport the gas to where it is needed. Specially designed trucks may also be used to deliver LNG to other storage facilities in different locations. There has been an increase in the number of LNG terminals authorized for use in the Atlantic Ocean including the Gulf of Mexico (Federal Energy Regulatory Commission, 2005). Many of the offshore proposals in the Gulf of Mexico propose the use of an open-loop, or once through, regasification technology that may utilize 100 – 200 million gallons of seawater per day. These facilities can subject early life stages of marine species to entrainment, impingement, thermal shock, and water chemistry changes. Mortality caused by open-loop LNG facilities could affect the health of some marine fisheries, including bluefin tuna.

Ocean Dumping

The disposal of dredged sediments and hazardous and/or toxic materials (*e.g.*, industrial wastes) containing concentrations of heavy metals, pesticides, petroleum products, radioactive wastes, pathogens, etc., in the ocean degrades water quality and benthic habitats. These effects may be evident not only within the immediate vicinity of the dumping activity, but also at farther locations, as well, due to current transport and the potential influence of other hydrographic features. The disposal of uncontaminated dredged material, including adverse effects on EFH and appropriate conservation measures are addressed in Section 6.6.2.4 of this chapter. Disposal of hazardous and toxic materials by U.S. flag vessels and vessels operating in the U.S. territorial sea and contiguous zone is currently prohibited under the Marine Protection Research and Sanctuaries Act (MPRSA), although under certain circumstances the Environmental Protection Agency may issue emergency permits for dumping industrial wastes into the ocean. Major dumping threats to the marine environment are therefore limited mostly to illegal dumping and accidental disposal of material in unauthorized locations. However, given the amount of debris that is deposited along the Nation’s beaches every year, including hazardous materials such as medical wastes, it is evident that effects from such dumping may be substantial.

10.5.2 Cumulative Impacts

The EFH regulations suggest that cumulative impacts should be analyzed for adverse effects to EFH. Cumulative impacts on the environment are those that result from the incremental impact of actions added to other past, present and reasonably foreseeable future actions. Such cumulative impacts generally occur in inshore and estuarine areas, and can result from individually minor, but collectively significant, actions taking place over a period of time.

These impacts include water quality degradation due to nutrient enrichment, other organic and inorganic contaminants associated with coastal development, activities related to marine transportation, and loss of coastal habitats, including wetlands and sea grasses. The rate and magnitude of these human-induced changes on EFH, whether cumulative, synergistic, or individually large, is influenced by natural parameters such as temperature, wind, currents, rainfall, salinity, etc. Consequently, the level of threat posed by a particular activity or group of activities may vary considerably from location to location. These multiple effects can, however, result in adverse impacts on HMS EFH.

Wetland loss is a cumulative impact that results from activities related to coastal development: residential and industrial construction, dredging and dredge spoil placement, port development, marinas and recreational boating, sewage treatment and disposal, industrial wastewater and solid waste disposal, ocean disposal, marine mining, and aquaculture. In the late 1970s and early 1980s the country was losing wetlands at an estimated rate of 300,000 acres per year. The Clean Water Act and state wetland protection programs have helped to decrease wetland losses to 117,000 acres per year, between 1985 and 1995. Estimates of wetlands loss vary according to the different agencies. The USDA estimates attributes 57 percent wetland loss to development, 20 percent to agriculture, 13 percent to deepwater habitat, and ten percent to forest land, rangeland, and other uses. Of the wetlands lost to uplands between 1985 and 1995, the U.S. Fish and Wildlife Service estimates that 79 percent of wetlands were lost to upland agriculture. Urban development, and “other” types of land use activities were responsible for six percent and 15 percent, respectively.

Nutrient enrichment has become a major cumulative problem for many coastal waters. Nutrient loading results from the individual activities of coastal development, non-point source pollution, marinas and recreational boating, sewage treatment and disposal, industrial wastewater and solid waste disposal, ocean disposal, agriculture, and aquaculture. Excess nutrients from land based activities accumulate in the soil, pollute the atmosphere, pollute ground water, or move into streams and coastal waters. Nutrient inputs are known to have a direct effect on water quality. For example, in extreme conditions excess nutrients can stimulate excessive algal blooms or dinoflagellate growth that can lead to increased turbidity, decreased dissolved oxygen, and changes in community structure, a condition known as eutrophication. Examples of such dinoflagellates or algae include *Gymnodinium breve,* the dinoflagellate that causes neurotoxic shellfish poisoning, dinoflagellates of the genus *Alexandrium,* which causes paralytic shellfish poisoning, *Aureococcus anophagefferens,* the algae which causes “brown tides”, and diatoms of the genus *Pseudo-nitzschia* which cause amnesic shellfish poisoning. *Pfiesteria piscicida* is a recently-described toxic dinoflagellate that has been documented in the water column in coastal areas of Delaware, Maryland, and North Carolina. Another *Pfiesteria*-like organism has been documented in St. John’s River, FL. This organism has been associated with fish kills in some areas.

In addition to the direct cumulative effects incurred by development activities, inshore and coastal habitats are also jeopardized by persistent increases in certain chemical discharges. The combination of incremental losses of wetland habitat, changes in hydrology, and nutrient and chemical inputs produced over time, can be extremely harmful to marine and estuarine biota, resulting in diseases and declines in the abundance and quality of the affected resources.

Future investigations will seek to analyze cumulative impacts within specific geographic locations (certain estuarine, coastal and offshore habitats) in order to evaluate the cumulative impacts on HMS EFH. Information and techniques that are developed for this process will be used to supplement future revisions of these EFH provisions as the information becomes available.

CHAPTER 10 REFERENCES

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